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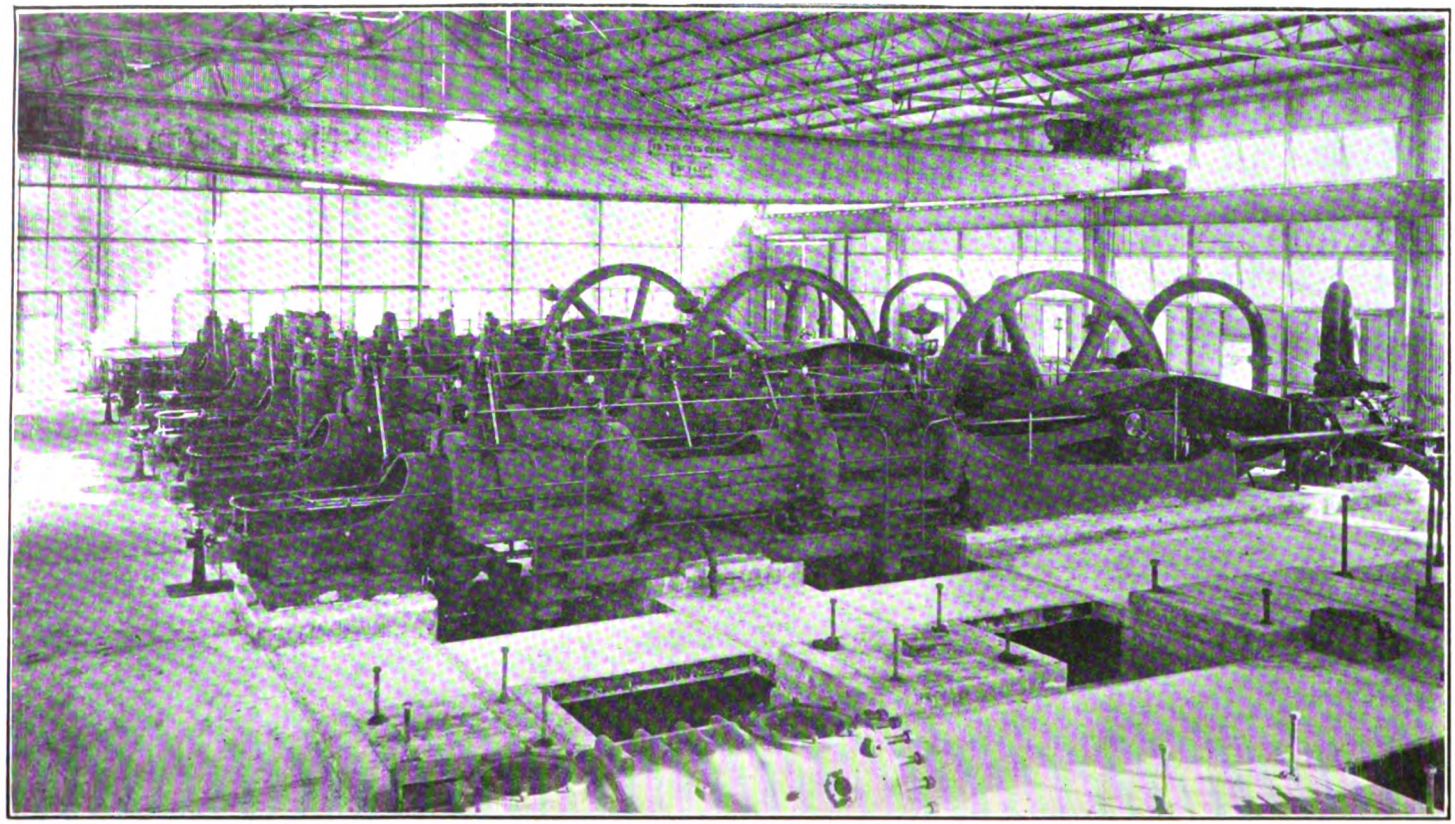

INTERIOR GAS COMPRESSOR STATION OF THE SOUTHERN CALIFORNIA GAS COMPANY, NEAR TAFT, CALIFORNIA (See page 344.)

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EDITORIAL

THE Common Council of Syracuse, New York, at the instance of Mr. W. T. Worley, city engineer, has amended the specifications for city pavements, removing provision for all macadam roads and substituting therefor a portland-cement base and Topeka surface. It is likely that the Topeka specification will also be used in cases where the practice has heretofore been to use sheet asphalt. This lends added interest to Mr. Eric Wold's article in this issue dealing with pavements in Burlingame, where the Topeka specification wearing surface has also been adopted for all city work.

IN an article by Mr. C. F. Braun on 'Feed-Water Heaters, Closed Type,' published in our issue of April last, is shown a chart for calculating mean temperature difference between the steam and water. This chart was copyrighted by the author in 1912, and as by error it was not so designated in the title, this means is taken of advising readers of *Western Engineering* against reproducing it in any form without authorization from the owner of the copyright.

NEWS has come from Pittsburgh to to the effect that the American Water Works & Guarantee Company has been sold for $1,250,000 to a reorganization committee consisting of the Bond Holders' Protective Committee of New York City. This is the first important step taken toward a reorganization of the Kuhn interests in which the property of the Sacramento Valley Irrigation Company and other large interests in Idaho and elsewhere are included. It is to be hoped that ultimately the financial difficulties will be overcome and that the Sacramento Valley project may be carried through to successful completion.

ATTENTION is directed to a communication received from Mr. William Mulholland with respect to the collapse of the Antelope Valley siphon and published in the 'Discussion' section. Further light is thrown on this subject in an account of the restoration of the siphon, prepared by the editor of the *Southwest Contractor* and published in their issue of April 18 last. In brief, the method employed was first to repair the break and then employ water under static pressure to re-inflate the collapsed steel pipe to its normal form. Of the total length of nearly 16,000 feet of steel pipe, some 10,000 feet had collapsed. This has been entirely restored to its original form by the method stated and there remain few evidences of the disaster. A few minor buckles show near the point of the break which will probably in time disappear. At the two transition points where the steel joins the concrete, the pipe is said to have assumed its original form without change of position, as is shown by the rivets entering the original crevices in the concrete. Some minor leaks in the vertical seams and around the rivets in the vertical seams occurred, which have been stopped by caulking. Mr. H. A. Van Norman was in charge of the repair work. We are glad to know that first impressions of the magnitude of the disaster were in-

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correct and that complete restoration of the siphon has been accomplished with comparative ease.

EXPERIMENTS recently made in the Fruitvale power house of the Southern Pacific Company to identify and counteract the causes of the excessive corrosion of boiler tubes, are of extraordinary interest to all users of water-tube boilers who are experiencing similar troubles. As yet it is too early to make more than brief mention of what has been done, but the results actually obtained justify the belief that whereas a few months ago the boilers were considered as practically doomed to early destruction, today their salvation is an accomplished fact. The method involves a systematic testing and treatment of the contents of the individual boiler, not of the plant as a whole, as is customary. The tests are made by the ordinary station force and the treatment is ridiculously simple and direct, compared with the ordinary treatment. The cost is materially less than by any known method in general use. The method differs in at least one other essential particular from those of our present acquaintance, in that, without modification, it is applicable to all waters regardless of their composition; hence, the usual claptrap of the salesman of boiler nostrums, "Give us a sample of your water for analysis and we will send you just the right compound for your particular conditions," no longer has a place in present day language. Again, it is rankly heretical in another important particular, since it permits safe operation with a saline content up to 2000 grains per gallon, a boon to those who must operate leaky condensers with salt water circulation. It does not cause priming. Any 'Doubting Thomas' will find his answer on the faces of those most concerned with the successful operation of the plant, and it is said that the electrical engineer in the Flood building is discussing the matter in a preliminary way with his friends. At a later date full publication is to be made. Just now he is looking for difficult cases of boiler corrosion and scaling on which to make demonstrations.

IN line with the work of protecting the oilfields from damage due to infiltrating water, which has been under way for some time in Kern county through an organization known as the Kern County Oil Protective Association, a similar organization has just been formed in the Coalinga district. Representatives of the Standard Oil Company, the Associated Oil Company, the Kern Trading & Oil Company, the California Oilfields, Limited, the California Petroleum Company, the Nevada Petroleum Company, the Traders Oil Company, and the Union Oil Company have signed the articles of agreement, while a number of the smaller companies have also agreed to join the movement. The activities of the new association will be conducted by a board of seven trustees, namely: Messrs. R. C. Baker, R. S. Hazeltine, Thomas Crumpton, C. A. Hiveley, I. J. Hardison, A. T. Beazley, and F. A. Sooy, whose duties will consist of ascertaining the cause of infiltration and determining what steps shall be necessary to remedy the evil and further to prevent infiltration from wells that may be sunk in the future. The members of the association agree that if any party or parties found to have been responsible for infiltration refuse or neglect to commence measures required to effectually shut out the water within ten days after receipt of notice

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from the trustees, the trustees will have the right to enter upon the property, take such remedial measures as they may deem necessary at the expense of the offending party and also to bring suit if necessary to collect the amount due. Funds for carrying on the work are provided through a *pro rata* assessment plan to provide a total of $1000 per month. Three-fifths of this amount is to be provided by *pro rata* assessments upon the total production of each company and two-fifths upon the acreage of the lands held. We have frequently pointed out in these columns not only the necessity for taking corrective measures in order to preserve the life of the oilfields, but also that movements of this character cannot succeed without the hearty coöperation of all concerned. Since legislative action on the part of the state, providing for this work and fixing adequate penalties for non-conformance with corrective measures deemed necessary, failed to receive the approval of the Governor, it is necessary that associations such as that in Kern county and the new organization just formed in Coalinga should undertake this work. It is in every sense a protective measure of vital importance to every oil producer and should receive the hearty financial and moral support of every one interested in the welfare of the industry.

Reinforced Concrete

It is generally known that cement as a material for construction was in use many centuries before the Christian era. The popular conception that adding as a reinforcement, material having tensile strength is a comparatively modern idea is wide of the mark, as reinforcement for materials deficient in tensile strength has been employed in the building trades for nearly, if not quite as long a period. Straw is admixed with adobe clay for manufacturing brick in Spanish-American countries, while it is common practice to mix animal hair with lime mortar for making plaster for the interior walls of buildings. A short time ago we published a brief note of the use of reinforced concrete in the construction of the hull of a canal boat, while as a matter of fact it is well known that many centuries ago boats in common use on the Nile were of wicker frame with a covering of clay. Tombs built on the Appian way, Rome, about 100 B.C. were found to consist of cement in which were imbedded bronze rods. A book published in 1830 suggests that roofs might be constructed of iron rods thickly imbedded in cement, while in 1854 a mason named W. B. Wilkinson is said to have taken out a patent for a floor of concrete and iron in Newcastle-on-Tyne. According to Mr. John P. Brooks of the Clarkson School of Technology, even methods that we are pleased to regard as modern are actually old. Recent discoveries in Central America show ancient buildings that have apparently been poured as a unit between wooden forms. Credit for the introduction of reinforced concrete as we know it today has been given to Jean Monier, a French gardener, who successfully built reinforced concrete water and gas tanks, sewers, arches, and floors.

In a paper read before the American Society of Civil Engineers in 1894, it was stated that Monier commenced this work in 1875. Even at the time this paper was read, European engineers were building reinforced concrete arches of over 150-foot span and only 6 to 8 inches deep at the crown. The

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introduction of reinforced concrete in the United States was slow, however, the first case on record being that of a building erected at Port Chester, New York, in 1875, and discussed by W. E. Ward in the *Transactions* of the American Society of Mechanical Engineers, Vol. IV, 1888. To San Francisco belongs the honor of having what is probably the first reinforced concrete bridge in the United States, a structure of 35-foot span erected in Golden Gate Park in 1889. From that time until about ten years ago, progress in reinforced concrete construction was comparatively slow. A few buildings were erected before the great fire of 1906, and it was the fire principally that drew attention to what may be regarded as the greatest characteristic of reinforced concrete, namely, permanence. The great disaster is still sufficiently fresh in our minds to enable us to remember the scene of devastation and ruin; a city reduced to piles of smoking débris in which the monotony of devastation was occasionally broken by a few remaining structures, which with few exceptions were found to be either wholly of reinforced concrete or having portland cement concrete as a fire proofing material. When the result of this costly test became apparent, there was a rush to rebuild with reinforced concrete. Anybody and everybody, competent and incompetent, became a concrete contractor. The inevitable result was the erection of a number of buildings that were far from being what they should have been. An improper proportioning of materials, and principally the use of unsuitable materials were the principal contributing factors. There is an idea prevalent in the minds of many people that rock is rock, gravel is gravel, and sand is sand, as far as concrete is concerned. Specifications for concrete construction are often loosely drawn in this particular, and even more loosely followed. In this issue a paper by Mr. Charles P. Berkey draws attention to the necessity for the scientific classification of rock for concrete construction. And what is no less important is the vital necessity for removing every particle of clay, dirt, or other foreign matter that would tend to prevent the portland cement from effecting a bond between the other materials that make up the concrete aggregate. Modern mechanical mixers are a great help in assuring that every particle of rock, gravel, and sand is thoroughly coated with hydrated cement, but the only sure course lies in the selection of materials suited for the purpose and then in seeing that every particle of foreign matter is excluded before the aggregate is mixed.

Those who assume that the pinnacle of the application of reinforced concrete has been attained are wide of the mark. In building construction, and especially in dwellings, the day will soon come when reinforced concrete houses will be built without forms at a cost within the reach of many. Trolley and telegraph poles, electroliers for city lighting, and even fence posts on the farm are rapidly becoming common. Manufacture of railroad ties is another of the comparatively new uses for this astonishingly adaptable material. Concrete for country roads as well as for city sidewalks has long ceased to be novel. The older applications have become recognized standards from which there is no departure. And what will be made of concrete next? We do not know. It would take less time to list the uses for which concrete is not suitable. And back of it all is one fundamental idea, permanence.

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REVIEW OF THE MONTH

IMPENDING war with Mexico has overshadowed all other events of the month. On April 9 an officer and seven men of the U. S. S. *Dolphin* were arrested by a squad of Mexican soldiers at Tampico. Demands were made for an apology from the Huerta government accompanied by a salute to the American flag. The Huerta government expressed its willingness to comply with this demand provided that the Mexican flag be saluted simultaneously. This request was denied, and the time limit placed by the United States Government at 6 p.m., April 18, having expired, Vera Cruz was occupied by men from the United States fleet which had assembled in the harbor. Steps have been taken to occupy other Mexican ports and a rapid movement of troops has been made to reinforce those stationed along the border and concentrated at various points of strategic importance. Diplomatic relations have been severed, and it seems that the long-expected crisis has arrived and that the policy of watchful waiting has been superseded by one of action. While the occasion for the change was trivial, it should be remembered that it was but the culmination of a long series of apparently studied insults to Americans on the part of the Huerta government, and back of it all are the lives lost, the tremendous personal hardship, and financial loss that has fallen to the lot of Americans in Mexico in the last four years. Diplomacy intervened at the psychological moment, however, and the good offices of three South American republics are being used in order to avert war. At present writing, indications for peace are favorable, and there seems to be a possibility that the warring factions of Mexico may be united to form a stable government.

SAN FRANCISCO has been chosen as the site for one of the regional reserve banks under the new Federal banking law. The others will be situated in Boston; New York; Philadelphia; Cleveland; Richmond, Virginia; Atlanta; Chicago; St. Louis; Minneapolis; Kansas City; and Dallas, Texas. The San Francisco district includes the states of Washington, Idaho, Oregon, Nevada, Utah, California, and the greater part of Arizona. The Federal reserve board, which is yet to be appointed by the President, will provide for the establishment of a number of branch banks subsidiary to each of the regional reserve banks. The next step to be taken by the organization committee will be the notification to banks entering the system of the plans for the districts. Each bank must subscribe 6 per cent of its combined capital and surplus, and the capitalization announced for each district is based upon this 6 per cent subscription. Great benefits are expected to accrue to the country as a whole through the operation of the new banking system; for, instead of concentrating the surplus funds of the country in New York, as was the result of the operation of the National Bank Act, the surplus funds of a community are concentrated in that community. The new law thus makes available funds for investment in local enterprises within the

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district where the funds are created. This, together with doing away with interlocking directorates, should go far toward correcting the evils due to the concentration of credit in Wall Street.

AFTER many months of negotiations the Union Oil Company has been sold. A deal has been consummated whereby the control passes first to the Western Ocean Syndicate and later to a holding company to be called the British Union Oil Company, Limited. Messrs. Andrew Weir, R. Tilden Smith, J. C. Currie, and J. B. Birkbeck, representing the new owners of the General Petroleum Company, have exercised the option held by the latter for the purchase of $15,000,000 nominal value of Union Oil Company's treasury stock at 85. In addition to this, Mr. Lyman Stewart, president of the Union Oil Company, has agreed to exchange his holdings of Union Oil stock amounting to $4,000,000 for 6 per cent cumulative participating preference shares in the British holding company. The participation rights are on a 50 per cent basis between 6 and 10 per cent. This means that the first 6 per cent earned goes to the preference shares. All subsequent earnings above 6 per cent and up to 14 per cent are divided equally between the preference and ordinary shares until the preference shares are receiving 10 per cent, or 4 per cent for each class over the 6 per cent cumulative. After the preference shares have received 10 per cent, all earnings accrue to the ordinary shares. Minority stockholders will be given an opportunity to exchange on the same basis as was afforded Mr. Stewart. The consummation of this deal places the Western Ocean Syndicate in control of nearly one-third of the petroleum production of California and, it is stated, fully one-half of the proved acreage. The Western Ocean Syndicate, in addition to the names before mentioned in these columns, is composed of steamship men of Great Britain, representing 75 per cent of the total tonnage.

THE General Pipe-Line Company has also been absorbed by the Western Ocean Syndicate, Limited. By the terms of the agreements, to which the stockholders of the General Pipe-Line Company have agreed, $4,000,000 first sinking fund 6 per cent bonds of the General Pipe-Line Company underwritten by a syndicate of New York bankers have been taken over by the Western Ocean Syndicate, together with $2,000,000 or 27 per cent of the Company's stock, which was also underwritten by the syndicate. It would appear to an outsider that Great Britain appreciates, first, the necessity for obtaining a supply of oil, and, second, that investments of this kind in the California field have nearly as good a guarantee of stability as if the territory were actually under the British flag. It has been quite difficult recently to finance oil enterprises, and it would appear that British financiers are more far sighted than those of our own country with respect to the possibilities of the California oilfields.

ACTIVITY in the California oilfields is by no means confined to British capital. Announcement has been made that the Royal-Dutch Petroleum Company and the Shell Trading & Transport Company, generally known as the Royal Dutch-Shell interests, have filed incorporation papers with the Secretary of State for the Valley Pipe-Line Company, having an authorized capital stock of $10,000,000, with Messrs. H. R. Gallagher, John Lawson, D. Adamson, W. Meisthke, and J. C. Van Eck as in-

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corporators. It is proposed to build a pipe-line from the Midway and Coalinga fields to San Francisco bay, the terminal to be in the vicinity of Port Costa. The capacity of the line will be a maximum of 30,000 barrels per day and is to parallel that of the Associated Oil Company. The properties recently acquired by the Royal Dutch-Shell interests include the California Oilfields, Limited, the Turner Oil Company, and the W. K. Oil Company. They have also contracted for 5000 barrels per day from the General Petroleum, Limited, in the Midway field. At present writing, therefore, they have a total production of upward of 20,000 barrels daily. This improvement in the marketing and transportation facilities of the state will do much for the petroleum industry.

ANOTHER spoke has been taken from the wheel of the Railroad Commission. According to a decision just handed down by the State Supreme Court, the refusal of the Commission to permit the Oro Electric Corporation to operate within the city of Stockton was an illegal act beyond the jurisdiction of the Commission, and therefore void. This is the first limitation that the courts have placed upon the sweeping authority given by the State Legislature to the Railroad Commission over public utility corporations in California. On the ground that the company at present operating at Stockton could furnish a more economical service without competition, the Commission some time ago refused to permit the Oro corporation to enter this territory. The Supreme Court declares, however, that the Railroad Commission had no such power within the limits of a city that has not, by the vote of its electors, surrendered its charter rights to regulate public service corporations. On December 30, 1912, the city of Stockton granted a franchise to the Oro Electric Corporation, permitting it to furnish electricity in the city. The Western States Gas & Electric Company was supplying service at that time, and in response to instructions from the Railroad Commission undertook certain betterments in its system of supply service and the Commission agreed to deny the Oro Electric Corporation a certificate of public convenience and necessity. The position taken by the Railroad Commission was that no company intending to engage in a specific public service shall begin construction without first obtaining a certificate of public convenience and necessity. The Oro corporation, in reply, contended that the Commission could not control the operations of a public utility corporation in cities of the third class, with municipal powers over such utilities, until the electors consent to transfer such powers to the Railroad Commission. The Supreme Court held that the terms of the Oro corporation's charter shows that the power was invested in the city of Stockton and that to grant a franchise and withhold the right to use it would constitute no grant at all. The court held further that if the state empowered the city to grant a franchise, it empowered the grantee to exercise his privilege. Another point in the decision is that in the opinion of the court, the people believed other cities would retain their powers until they chose to surrender them and that the utilities act allows the cities to decide whether they will keep or relinquish such powers, a right that the court cannot take away from the people. The cities are considered to have control of their utilities without regard to whether they were in op-

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eration at the time the Commission was created. This decision is of far reaching importance to all public utilities operating in California, and it would appear that competition for electric light and power service may still be possible, except for such communities which have already turned the administration of their public utility corporations over to the Railroad Commission.

ANOTHER case which resulted in a reversal for the Railroad Commission is that recently decided by the Supreme Court on petition of the Del Mar Water, Light & Power Company. This Company had been directed by the Commission to furnish a consumer with water, after the Company had refused to do this on the ground that it was not a public utility, but merely a company that was the incorporated water department of the South Coast Land Company. The Commission defined it to be a public light and power utility, after reading the articles of incorporation of the Company. The decision of the Supreme Court declares that no matter what the charter of a corporation may state as to its rights to administer a public use, the corporation does not come under the control of the Railroad Commission until it actually begins to serve the public. Another case now pending before the Supreme Court presents a possibility of a further curtailment of the powers of the Commission. This is the Glendale Water Company case, and it will determine whether a public utility may be compelled by the Commission to serve a new consumer.

PLANS for furnishing a much needed water supply to the Sunset and Richmond districts of San Francisco have been submitted to the San Francisco Board of Supervisors by Mr. M. M. O'Shaughnessy, and it appears likely that the plans will be adopted. Negotiations for the purchase of the Spring Valley Company's property and other legal entanglements have prevented the latter from undertaking the extension of its mains and distribution system in the residence districts mentioned. As the time that will necessarily elapse before the Hetch-Hetchy supply can be available is a matter of years, it is imperative that steps be taken to overcome the water shortage. It is proposed to sink wells on city property in the western part of the Sunset district and at a considerable distance from Golden Gate Park. It is stated that in keeping dry the deep ditch which is being dug through the park for the Mile Rock sewer connection, over 1,500,000 gallons are being pumped into the ocean daily. Mr. O'Shaughnessy has estimated that from wells which could be sunk in city property in the southwestern part of the Sunset district a supply of at least 3,000,000 gallons daily could be secured. Such a supply would be sufficient to meet the needs of the Richmond and Sunset districts for several years, while during the first year of operation a considerable amount could be economically diverted to the needs of the Exposition. It is estimated that the entire system can be installed by the city at a cost of $1,000,000. The first step has been taken in the form of a resolution calling for an appropriation of $25,000 to sink wells which will serve as a test of the volume of water that can be produced. Approximately one year's time will be required for the completion of the whole development. San Francisco may develop a local water supply that will prove to be of considerable importance.

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Burlingame Pavements

By ERIC WOLD*

DURING the years 1910 and 1911 the city of Burlingame contracted for the construction of permanent pavements on several short stretches of streets. These pavements were really experiments and ranged from oil macadam to a pavement consisting of a concrete base with a sheet asphalt wearing surface. The following list is of interest:

Burlingame avenue consisting of 4-in. concrete base and 2-in. sheet asphalt top at 18c. per square foot.

Bellevue avenue consisting of 5-in. asphaltic concrete, of the Warren patent type at 17.8c. per square foot.

San Mateo drive consisting of 4-in. concrete base, 1-in. binder and 2-in. sheet asphalt wearing surface at 23.8c. per square foot.

Park road consisting of 4-in. concrete base, and 2-in. asphaltic concrete of Warren patent type at 21.6c. per square foot.

Chapin avenue consisting of 6-in. oil macadam at 12.5c. per square foot.

These pavements gave the Burlingame trustees the opportunity to study at close range the merits of the several classes of pavement represented, and, after due observation and consideration, they decided that all their pavements of the future should be laid on a concrete base and that the wearing surface should be of a non-skidding type.

The campaign for permanent streets commenced with the inauguration of the new Board of Trustees in April 1912, which decided that the city must be paved. All being successful business men, the problem presented itself to them as a business proposition. They fully realized the magnitude of their undertaking; that is, to pave 35 miles of street in a city of 3000 inhabitants, and were fully aware of the benefits to be derived by a suburban city from such improvements.

The decision was immediately made that the work should be done in wholesale lots, thus getting the benefit of close competition and wholesale prices. It was decided to let at least 2 miles of work at a time, or from 400,000 to 500,000 sq. ft. The result of this has been gratifying, for the writer believes that Burlingame has done its street work at a lower cost than any city in California under similar proceedings—that is, the 'Improvement Act of 1911.'

From the experiments above enumerated, Burlingame concluded that it must have a non-skidding pavement of the asphaltic macadam. Bitulithic, or Warren type, but the idea of paying 25c. per square yard royalty for such a pavement was unsatisfactory, and after much investigation and study the 'Topeka Specifications' were adopted as the Burlingame standard, and the service given by this pavement during the past two years has justified the choice. We find that it is non-skidding, malleable, and tough, not too hard in winter nor too soft in summer,

*City Engineer of Burlingame, 423 Sharon Bdg., San Francisco.

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DOUGLAS AVENUE, BURLINGAME. PORTLAND CEMENT CONCRETE BASE, TOPEKA SPECIFICATION WEARING SURFACE.

EL CAMINO REAL THROUGH BURLINGAME, 44 FT. WIDE, 5-IN. PORTLAND CEMENT CONCRETE BASE, 1½-IN. TOPEKA SPECIFICATION WEARING SURFACE.

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and, best of all, it is *self-healing.*

Of all the types of asphaltic pavement in use on the Pacific Coast, standard sheet asphalt undoubtedly presents the most permanent wearing surface, the only objection being its slipperiness. In the Topeka surface we find practically the same mixture as that of the sheet asphalt with the addition, however, of about 25% of a rock aggregate all of which will pass ½-in. mesh.

This aggregate does produce the necessary rough surface to prevent the skidding of rubber tires and gives a better foothold for horses, and yet these small stones are not so numerous but that if one does fracture and become dislodged by the sharp-shod horse the surrounding asphaltic mortar will work into the hole and heal the surface. The asphaltic concrete, Bitulithic and Warrenite pavements, on the contrary, with their larger and more closely packed coarse aggregate will ravel, because there is not sufficient asphaltic mortar to heal a displacement.

There has been much discussion among the engineers and attorneys of California as to whether the 'Topeka Specification' is an infringement of the Warrent patent, notwithstanding the decision rendered May 26, 1910, by the Hon. John C. Pollock, sitting as circuit judge in the United States Circuit Court, District of Kansas, in the case of Warren Brothers Co. *v.* City of Topeka and the Kaw Paving Co., from which I quote as follows: "And it further appearing that the pavements as actually constructed in the cities of Topeka and Emporia, Kansas, do not infringe on the claims of the complainant's Patent No. 727,505 sued upon in this case, and that any pavements hereafter constructed in substantial compliance with the formulas shown in the following summary:

Bitumen	7 to 11%,
Mineral aggregate passing	
200-mesh screen	5 to 11%,
40-mesh screen	18 to 30%,
10-mesh screen	25 to 55%,
4-mesh screen	8 to 22%,
2-mesh screen	less than 10%,

sieves to be used in the order named, would not infringe on the claims of said patent." This decision leaves no doubt as to the legal status of the 'Topeka Specification.'

I will also quote from one of the original specifications of this type of construction, copyrighted in 1909:

"Preparation of Wearing Surface: The mineral aggregate, as above described, shall be heated in suitable appliances from 225° to 325° Fahrenheit. It shall be measured off and combined with the stone dust, where stone dust is required, and with the asphaltic cement as before described in such uniform and accurate proportions as to produce in the finished pavement a mixture similar and equal to that laid during the year 1893 in the pavement on Lang avenue, between Penn avenue and McPherson street and in the city of Pittsburgh, state of Penn.; and also laid in the pavement on Bellefield avenue from Forbes street to Center avenue in the same city, which was approved and accepted by the city of Pittsburgh, state of Penn. on the 20th day of January 1897 and having an average composition between the limits specified as follows:

Bitumen	7 to 11%,
Mineral aggregate passing	
200-mesh screen	5 to 11%,
40-mesh screen	18 to 36%,
10-mesh screen	25 to 55%,
4-mesh screen	8 to 22%,
2-mesh screen	less than 15%,

sieves to be used in the order named."

The fact that a pavement practically the same as the 'Topeka Specifications' was laid on Lang avenue, Pittsburgh,

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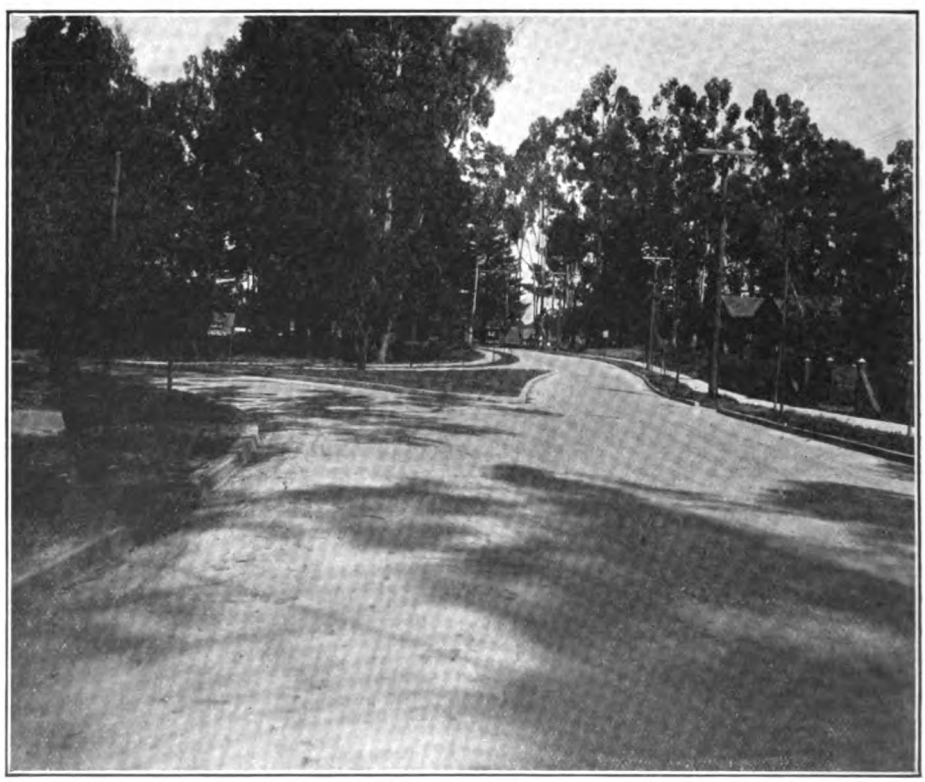
in 1893, and referred to in 1909 as a standard for imitation, speaks well for the wearing qualities of 'Topeka' pavements.

Since leaving the experimental stage and commencing on our street construction campaign, Burlingame has consistently specified and constructed concrete base, upon which to lay the wearing surface, using 5 in. for the streets receiving heavy traffic and 4 in. for the light traffic streets, and Burlingame has found this thickness ample. El Camino Real was constructed with 5-in. concrete base and 1½-in. wearing surface. This road receives the heaviest traffic of any street in the city, said traffic consisting of a heavy motor traffic, auto and horse-drawn vehicles in number as high as 7000 per day. A large proportion of the peninsula freight is carried by auto trucks over this road, deliveries being made as far as San Jose on the south and Halfmoon Bay on the west, to and from San Francisco. This road, after 18 months of this traffic, shows no sign of deterioration and has probably received more favorable comment from the traveling public than any road in northern California.

Burlingame takes great pride in its pavements, and the people have shown their faith in the type of pavement specified and the benefits derived from permanent pavement by heartily supporting the administration endorsing the proposed work (all of which has been done under the "Improvement Act of 1911") at public meetings, both



WILLOW AND WALNUT AVENUES, LOOKING TOWARD EL CAMINO REAL; 4-IN. PORTLAND CEMENT CONCRETE BASE, 1½-IN. TOPEKA SPECIFICATION WEARING SURFACE.

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before the proceedings were initiated and during construction.

When the present contracts are completed, 18 of the total of 35 miles of streets will have permanent pavement accepted for a term of 20 years by the city, and the good work will go on.

Prices

The following schedule of prices of street work received by Burlingame during the past two years are consistent and compare well with the large state and county jobs let during the same period. I have left out the prices of curbs, gutters, sewers, etc., which were part of these contracts, as they would only confuse and make the schedule cumbersome.

Contract. Description	Sq. ft. paving.	Cu. yd. grading.	Pavement sq. ft.	Grading cu. yd.
Howard ave. (4-in. conc. base 1-3-6, 1½-in. Topeka top)	373,187	*	13.39c.	...
East Lane. (4-in. conc. base 1-3-6, 1½-in. Topeka top)	23,210	....	13.39c.	...
El Camino Real. (5-in. conc. base, 1-2½-5, 1½-in. Topeka top)	430,945	*	15.09c.	...
Oak Grove ave., Floribunda ave., etc. (4-in. conc. base, 1-3-6 1½-in. Topeka top)	187,420	*	14.03½c.	...
Burlingame park 2 and 3. (4-in. conc. base 1-3-6 1½-in. Topeka top)	453,260	16,600	12.07c.	60c.
Burlingame park 4 and 5. (4-in. conc. base, 1-3-6½in. Topeka top)	76,308	3,202	12.09c.	55c.
Easton drive. (4-in. conc. base, 1-3-6, 1½-in. Topeka top)	53,248	2,058	12.05c.	60c.
Buri Buri avenue. (5-in. conc. base, 1-3-6, 1½-in. Topeka top)	39,725	2,180	13.06c.	60c.

*Howard avenue, East Lane, El Camino Real, and Oak Grove avenue bids were let for grading and paving combined. The grading, however, consisted of but little more than displacement and was estimated at 1½c. per square foot.

Bids were received on the Howard Avenue contract and East Lane contract at the same time; also, El Camino Real and Oak Grove avenue, etc., were let together, also Burlingame Park No. 2 and 3, Burlingame Park No. 4 and 5, and Eastern Drive and Buri Buri avenue were let together.

Since the writer commenced specifying the Topeka type of paving, he has kept statistics on this type of pavement, not only in Burlingame, but in other parts of the state and in the United States. This pavement was adopted in May 1912 by the city of Burlingame, and since that time it has been specified by Sacramento, San Mateo, Stockton, Hollister, Mayfield, Los Gatos, South San Francisco, Hillsborough, San Francisco, and by the State Highway Commission for its highest type of road.

Probably the finest paved addition to any city in California is that of St. Francis Wood, an addition to San Francisco. Professor Sturgeon, of the University of California, was secured by the proprietors of this addition as consulting engineer, and, after thorough investigation, he adopted the 'Topeka Specifications' as the pavement for the addition.

A large number of cities of the Middle West use this character of pavement exclusively, and one of the boroughs of New York City (Queens) laid during the year of 1912-13, 5,894,000

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sq. ft. of 'Topeka' pavement.

The following is the specification used by the city of Burlingame:

Asphaltic Aggregate

"The asphaltic aggregate shall consist of washed gravel and sand, or crushed rock and sand, free from any foreign substance, mixed so as to pass a ½-in. screen and produce the following specified proportions:

Bitumen	8 to 10%,
Mineral aggregate passing	
200-mesh screen	5 to 10%,
100-mesh screen	7 to 15%,
40-mesh screen	18 to 36%,
10-mesh screen	25 to 55%,
¼-inch screen	17 to 22%,
½-inch screen	less than 10%,

which shall be heated to from 225 to 325°F., and mixed in a manner to thoroughly coat each particle of stone, gravel or sand and produce a uniform mixture. The asphaltic concrete prepared as aforesaid shall then be hauled on the street, the concrete base of which must be thoroughly dry and free from foreign matter, and spread while hot with hot iron rakes or shovels, and thoroughly rammed or tamped into position in a manner to produce when thoroughly compressed by tamping and rolling a thickness of 1½ inches.

"The asphaltic concrete mixture shall contain enough mortar to fill all voids and come to the surface of the pavement as free mortar, when rammed and rolled, and produce a solid mass. The final compression shall be produced with a steam roller weighing not less than 5 tons, the rolling to be continued as long as the asphaltic concrete will take any compression."

Some engineers specify that a binder consisting of a paint coat of asphalt shall be used to cement the pavement to the concrete base, but the writer finds this entirely unnecessary, as the pavement lies on the concrete like a sheet of lead. It neither creeps nor rolls like sheet asphalt. The flush coat with screenings is also unnecessary and as much out of place as a like coat would be on sheet asphalt. A thin coating of hydraulic cement swept evenly over the surface immediately after laying will thoroughly water-proof the same and give more satisfactory results than the 'squeegee' coat.

The writer has found the hot hand roller unnecessary and that it may do more harm than good. The aggregate is a very dense one, and the steam roller of 4 to 6 tons may be used for compression about as soon as a load of the aggregate is distributed. A more even and a denser pavement can be secured by discarding the hand roller.

In addition to the Burlingame contracts given above, the writer, as engineer, has caused to be let 654,400 sq. ft. in San Mateo park, San Mateo. Also 854,780 sq. ft. in the Easton addition to Burlingame. Plans and specifications have been prepared on approximately 1,500,000 sq. ft. of additional pavement in Burlingame with the same specifications. Under the bond issue of San Mateo county, several contracts for concrete base and 'Topeka' wearing surface have been let. A number of other contracts along these lines are contemplated by the County Board of Supervisors.

The 'Topeka Pavement' will come into more general use in California as the public becomes aware of its merits. What with the wearing qualities of the standard sheet asphalt and the non-skidding qualities of the asphaltic macadam pavement, as they are known in California, 'Topeka' is less expensive to construct than the former and escapes the royalty of the latter.

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Cementing Oil Wells as a Problem in Cement Chemistry

By FREDERICK W. HUBER *

THE problem of excluding from the oil sand any waters encountered in the drilling of an oil well, is one with which the majority of operators have had to do. The various mechanical appliances and methods for placing the cement need not be considered here. Perhaps too much thought and ingenuity have already been expended upon things mechanical, to the neglect of the chemical factors entering into the problem.

In reviewing the various methods for cementing, one cannot but be impressed with the total absence on the part of the operator of any knowledge of the chemical and physical characteristics of the material he is using. Where this knowledge is not entirely lacking, one finds the operator proceeding along entirely empirical lines. The element of 'luck' seems to be the governing factor in cementing oil wells.

The writer knows of no attempts having heretofore been made to scientifically study the conditions existing in an oil well and their effect upon the hardening of the cement. He has, it is true, known of elaborate analyses having been made upon the various brands of cement to determine their present composition. Such tests have only served to bring out the already well-known fact that the composition of various brands of portland cement vary only within very narrow limits, and that the analyses throw no light whatever upon the manner in which the various constituents are combined.

A problem must first of all be understood before it can be solved.

The problem of cementing an oil well, from a chemist's standpoint, is to allow the cement to harden properly. The conditions necessary for proper hardening in the environment in which the cement finds itself at the bottom of an oil well, are not, as may be supposed, very simple. The fact that a cement will either harden, or refuse to harden, in a well, is a statement in itself simple, but the cause for which will, what to the lay reader may seem, be going far afield. Before the problem can be solved the chemical and physical nature of portland cement must be understood.

Physical-Chemical Nature of Portland Cement

Much confusion exists as to the difference between cement in the dry state and the cement gauged with water. Portland cement clinker, which is the result of calcining the accurately proportioned raw mixture of limestone and clay materials, possesses no hydraulic properties whatever. The clinker can be kept under water indefinitely without undergoing any chemical change or manifesting any tendency to 'set up', but upon having an adequate surface developed by grinding, it rapidly re-

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acts with water, and the resulting reactions bring about the familiar phenomena of hardening or 'setting up.'

Dry cement is essentially a supersaturated solid solution of lime, silica, alumina, and iron, and its structure is principally crystalline. Upon being mixed with the necessary amount of water its crystalline components are dissolved, and there results a colloidal complex. The reactions which will take place in this colloidal complex are dependent entirely upon the environment in which it is placed, and the end product will either be entirely insoluble or relatively soluble, depending upon the factors influencing it during the hardening process.

From the very nature of colloids, it is to be expected that the presence of electrolytes will exert a profound influence upon the end product. The end product of the reaction taking place in a favorable environment is the formation of an insoluble product from the colloids (hydrosols) by being properly coagulated into hydrogels. The first reaction taking place in a cement mortar is the formation of a skeleton of crystalline products by the combination of lime, alumina, and iron.

These products viewed under the microscope present needle-shaped and hexagonal crystal forms. It is important to note that the silica does not enter into this initial reaction. The formation of this skeleton of crystalline material is necessary to set in motion the reactions which subsequently take place, and when cement is allowed to harden under favorable conditions, the end product is not crystalline, but amorphous. If, however, the cement hardens in an adverse environment, the products will be almost entirely crystalline; but by established physical chemical laws, it is known that crystalline products are relatively soluble.

A cement hardening by crystallization alone can serve as a binder where it is protected from the solvent action of water.

A cement which refuses to 'set up' in an oil well and is subsequently removed, presents to the casual observer the same appearance that it had at the time it was deposited, but a closer microscopic examination will reveal an entirely changed structure, and it is possible that the cement did harden or 'set up,' but that the products of the reaction were decomposed as quickly as formed.

For the proper hardening of a cement by the formation of an insoluble hydrogel by coagulation, the reaction will be controlled by the factors—temperature, pressure, and concentration, and in the final hardening by this process, the silica and lime alone bring about the reaction and give to the mortar its peculiar properties.

On the network of crystals that we have mentioned above, there separates a gelatinous mass of hydrous silicic acid. This compound immediately starts to adsorb the lime hydrate, which is immediately formed upon adding water to the cement. During this process of adsorption the hydrous silicic acid gel undergoes an enrichment in lime which chemically combines with it.

No compounds of definite composition are, however, formed, as this fixation of lime proceeds indefinitely, and it is to this process of adsorption that the growth in strength of portland cement is to be attributed. During this process of adsorption there is formed around each grain of cement a semi-permeable diaphragm through which the pure water passes, but which does not permit the passage of dissolved salts (the principle of dialysis). The water so entering further into the cement grain again produces a local dis-

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sociation, and the whole process is repeated indefinitely up to such a point at which the outer layers of the semi-permeable diaphragm become so dense by the adsorption of lime and its fixation, that they become impermeable, and the hardening is completed.

A very striking proof that this is the condition which exists, is to be had in the regrinding of neat cement which has been 'set-up' for some time. By grinding such a hardened mortar to its original fineness, we can develop a fair percentage of its original strength, which is to be explained by the fact that we have opened up and exposed to the action of water the unattacked portion of the cement grain. The product formed by the adsorption of lime by the hydro-silica gel is amorphous. The hydro-silica gel, however, can adsorb and fix many other electrolytes. When the cement mortar is placed in water impregnated with a certain class of salts, the salts are adsorbed and fixed by the hydro-silica gel with the formation of crystalline compounds, and the end product is soluble.

The conditions in an oil well are so far removed from those existing above ground, that it is safe to say no cement can be prepared which would fit all of the varying conditions. It is important, however, that the cement be of such physical constitution as to make it possible to react and properly harden in the treated water within the well.

The writer has in his operations in the oilfields used a specially prepared oil-well cement made for him by the Riverside Portland Cement Co. He does not wish to convey the impression to the reader that all oil wells need to be chemically treated. He has had no experience whatever on wells which could be cemented by the ordinary methods in use. He has, however, had to do with a great number of wells which have heretofore defied all previous attempts to shut off the water, and he has invariably found that by so modifying the conditions of concentration in the well water and the protection of the cement by the addition of a protective colloid, that he has brought about the desired result.

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Compressor Plant of the Southern California Gas Company

By CHARLES T. HUTCHINSON

WASTE of natural gas in the California oilfields is enormous. This is due principally to a lack of a market for the product, for, with the exception of the Los Angeles field, the various sources of natural gas supply differ from great rivers in that they are not always situated close to large cities. Operators in the field make the most of their opportunities as far as the utilization of natural gas for their own purposes is concerned. In districts where light oil is produced, gasoline manufacture from casing-head gas is rapidly reaching the proportions of an industry. In the Coalinga and Kern River fields, where comparatively little natural gas is produced, operators conserve the supply for the operation of gas engines, for fuel in generating steam, and for supplying heat for dwellings. The Midway and Sunset fields, however, are lavish producers of natural gas. Many gas wells can produce ten, fifteen, and even twenty million cubic feet of natural gas per day at pressures varying from 250 to over 1000 lb. per square inch. In these fields it is a case of the embarrassment of riches; gas is dispensed for all sorts of purposes with a lavish hand. A great quantity exhausts into the atmosphere and is lost forever. Natural gas under high pressure is used as a substitute for compressed air in pumping, in other cases it is used instead of steam for operating steam engines, while the ordinary uses such as the operation of gas engines, fuel for steam boilers, lighting, cooking, and heating during the winter months are also in vogue. All of the small towns adjacent to the field have natural gas piped from the wells.

It must not be assumed from this, however, that gas is cheap to the one who has to buy it. The gas rate to domestic consumers at Taft, which is in the very heart of the natural gas region, is $1 per 1000 cubic feet, a rate higher by far than that paid for the manufactured product in San Francisco. This rate is now in process of revision by the California Railroad Commission. The city of Bakersfield, 40 miles distant, is supplied with natural gas for domestic consumption, and until a group of San Francisco and Los Angeles capitalists conceived the idea of piping natural gas to Los Angeles this was the extent of the use to which the enormous supply was put.

While piping natural gas a few miles to serve an inland town is not a matter of very great moment, the Midway-Los Angeles line is another matter. A large capital investment was required, which, for economic reasons, involved the determination as nearly as possible of the probable life of the field as a source of gas supply. Another factor of nearly equal importance was the probable drop in natural pressure at the wells resulting from withdrawing

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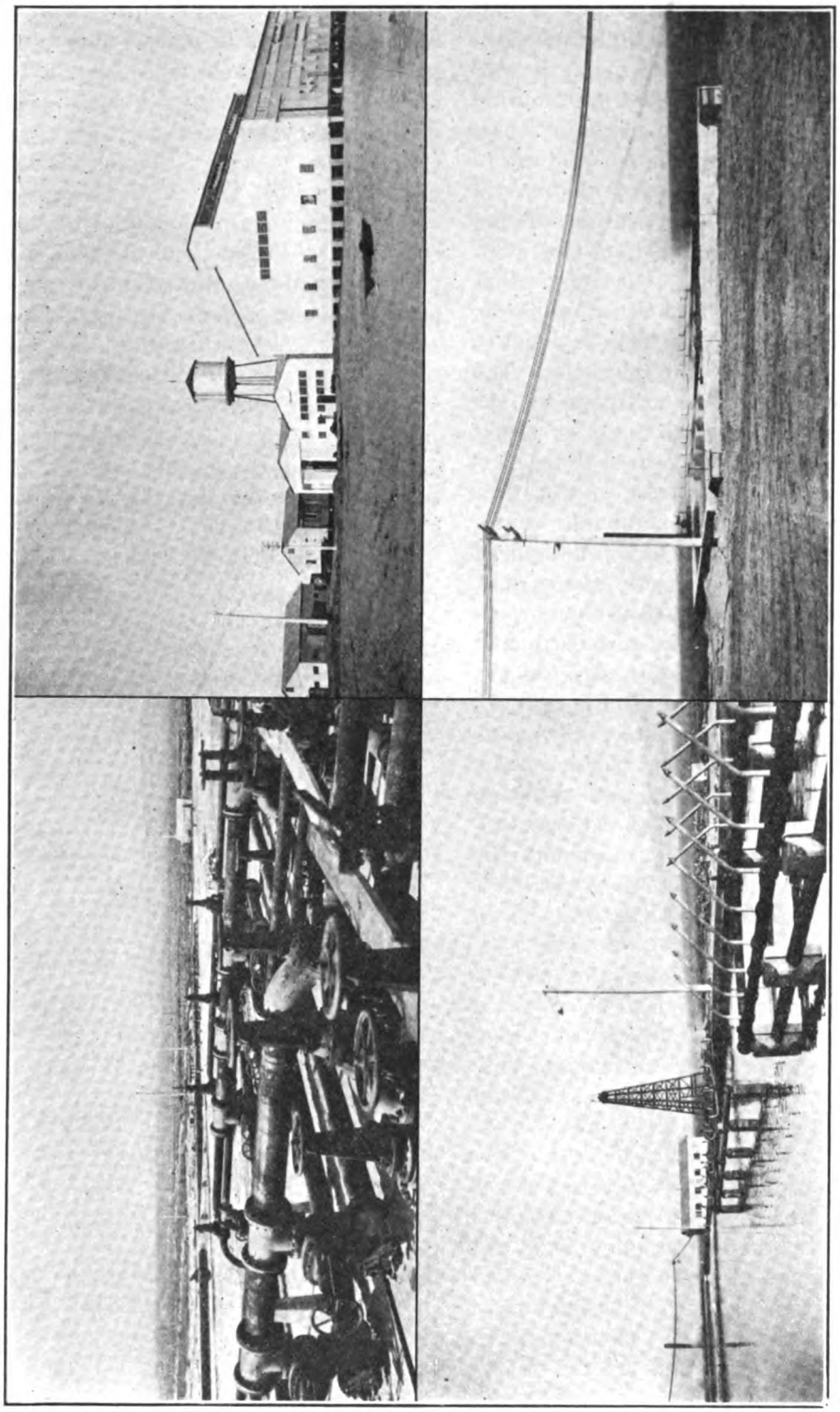

EXTERIOR OF SOUTHERN CALIFORNIA GAS CO.'S COMPRESSOR PLANT.

CONCRETE POND FOR COOLING COMPRESSOR AND ENGINE JACKET WATER.

DISCHARGE PIPING AND BY-PASS ARRANGEMENT FOR COMPRESSED GAS.

CONCRETE POND FOR INTERCOOLING WATER, SHOWING SPRAY NOZZLES.

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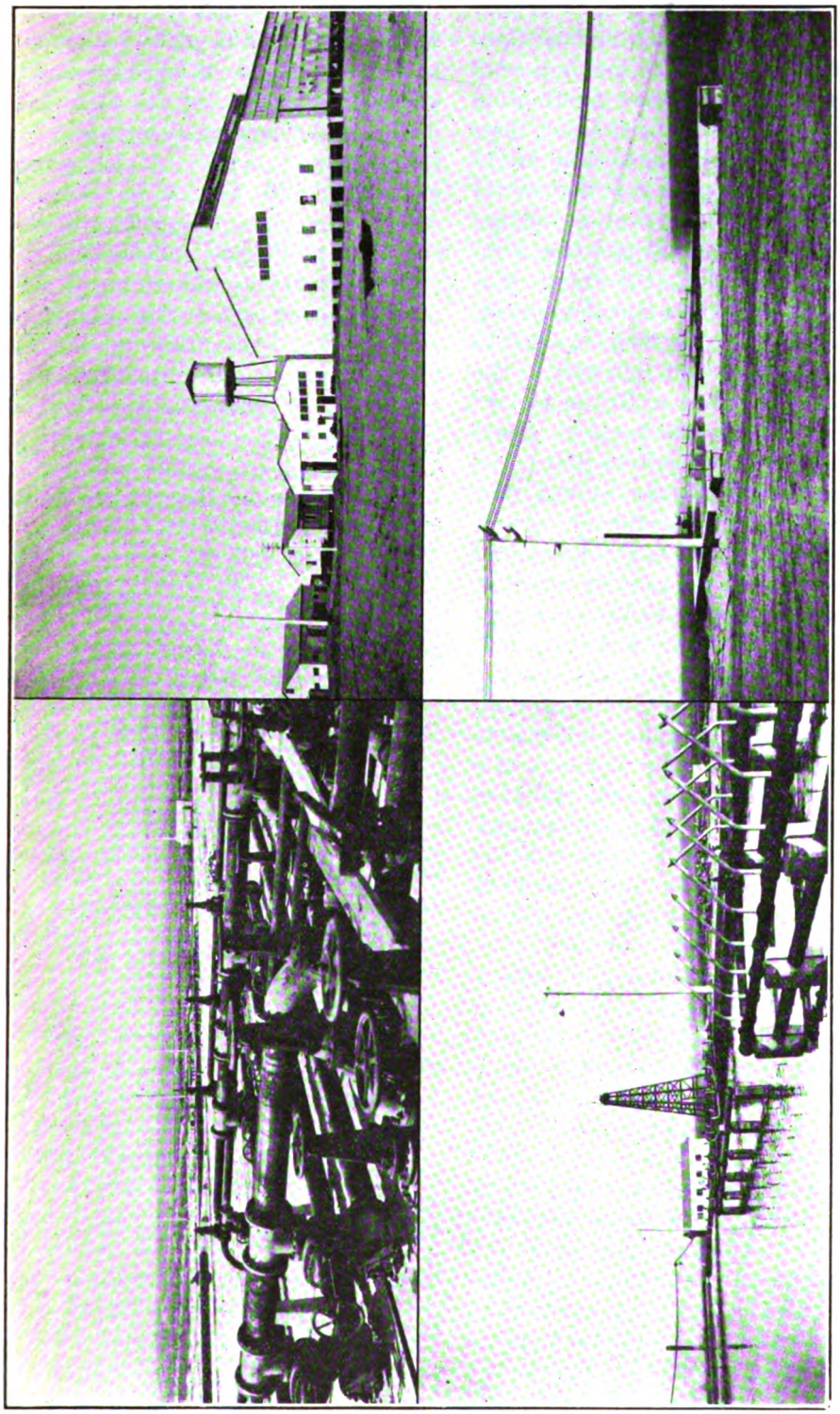

DISCHARGE PIPING AND BY-PASS ARRANGEMENT FOR COMPRESSED GAS.

CONCRETE POND FOR INTERCOOLING WATER, SHOWING SPRAY NOZZLES.

EXTERIOR OF SOUTHERN CALIFORNIA GAS CO.'S COMPRESSOR PLANT.

CONCRETE POND FOR COOLING COMPRESSOR AND ENGINE JACKET WATER.

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ten to fifteen million cubic feet of natural gas daily. The California Railroad Commission, at the hearings conducted for the purpose of determining the wholesale rate for gas, based their decision upon a probable life of 10 years, and authorized a rate that would provide for the amortization of the capital investment of the pipe-line within that period. The other factor, that of probable drop in natural pressure, was one for which the Company had to provide on its own initiative. The operation of a public utility nowadays implies a constant readiness to serve, so means had to be provided for furnishing artificial pressure at any time and at short notice, should the natural pressure drop below the point required to deliver the full capacity of the pipeline to the Los Angeles consumers.

Three companies were formed to handle the business. The Midway Gas Co. is the wholesaler, the Southern California Gas Co. distributes the gas to the consumer, while the Northern Exploration Co. is drilling gas wells on leased ground to supplement the supply furnished under contract with the Honolulu Consolidated Oil Co., which is the largest producer of natural gas in the field.

The main gas line is 12¾ in. outside diameter, 112 miles long. For the entire distance 33-lb. line pipe was used, the working pressure maximum being 450 lb. J. G. White & Co. designed and constructed the pipe-line which has recently been completed.

The gas compressor plant as a whole includes a main power house, auxiliary power house, and a pumping plant for water supply. An excellently equipped machine shop and garage have also been built, so that the entire plant is practically independent as far as ordinary repairs and maintenance are concerned.

There are three gas compressor units, with foundations in place for a fourth in case it should be necessary to increase the capacity of the plant later. Each gas compressor includes a 4-cylinder twin tandem duplex natural gas engine made by C. & G. Cooper Co. of Mount Vernon, Ohio. Two of these engines are direct connected to high pressure compressors and one to a low pressure compressor, the compressor ends having been made by the Hall Steam Pump Co., of Pittsburgh, Pennsylvania. The general specifications are:

Rated horse-power	965
Number of cylinders	4
Diameter of cylinders, inches	21½
Stroke of cylinders, inches	42
Revolutions per minute	107
Diameter piston rods, inches	6¼
Diameter cross-head pins, inches	8
Length cross-head pins, inches	9
Diameter crank pins, inches	10
Length crank pins, inches	9
Diameter crankshaft, inches	17
Diameter main bearings, inches	16
Length main bearings, inches	30
Diameter flywheel, feet	16
Weight flywheel, pounds	29,000
Total weight engine, pounds	297,000
Weight of heaviest piece, pounds	28,000
Floor space, feet	22 by 62
Jacket water required per hour at 120°F., gallons	9,500
Combined total weights, engine and and compressor:	
High pressure unit	327,000
Low pressure unit	357,000

The general specifications of each gas compressor are as follows:

	High pressure.	Low pressure.
Number of cylinders	2	2
Diameter of cylinders, inches	12	19¾
Length of stroke, inches	42	42
Delivery pressure, pounds	450	150
Number of suction valves	8	13
Diameter suction valves, in.	3	3
Number of discharge valves	8	8
Diameter discharge valves, in.	2⅞	2⅞
Quantity of jacket water per hour at 120°F., gallons	2500	2500

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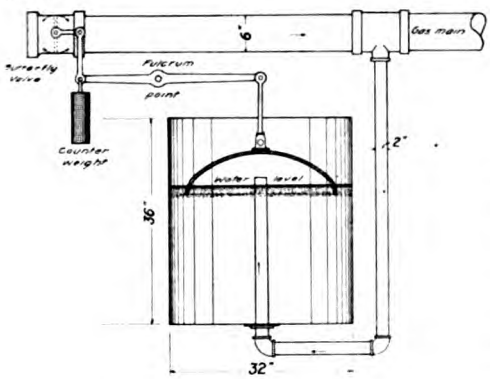
The total theoretical combined displacement of free gas per day of 24 hours is 17,650,000 cu. ft. The volumetric efficiency is guaranteed to be 83½% based upon gas of 100% saturation, giving an actual capacity of 15,200,000 cu. ft. It is expected at present that the daily output will be approximately 10,000,000 cubic feet.

The gas fuel for operating the engines is piped from the gas wells to a 2-in. pressure regulator which receives the gas at any pressure up to 600 lb. and reduces it to from 50 to 60 lb. At this pressure the gas is discharged into a 12-in. pipe which carries it to a 4-in. low pressure regulator which reduces the pressure to 8 ounces. From this point the gas is piped to a gasometer which reduces the pressure to atmospheric.



GASOMETER AND CONNECTIONS.

The gasometer consists of a galvanized steel tank 32 in. diameter and 36 in. high. Gas from the main is piped to the tank and discharges under a bell-shaped float which rests upon water with which the tank is partly filled. A series of levers connects the float with a butterfly valve in the gas line. Any variation from normal pressure in the gas line to the engine causes the float to rise or fall and thereby open or close the butterfly valve. This maintains a uniform pressure in the engine gas supply. In case of trouble with the gasometer, however, means are provided to by-pass the gas and take the supply direct from the main line.

The exhaust pipes from the engines are equipped with water seals to prevent steam or water from blowing back from the other units.

The lubrication for each engine is accomplished by means of Richardson multiple oil pumps. Oil from the bearings, slides, and other parts drains to a settling tank. One end of an oil pump, direct driven from the engine crankshaft, delivers the oil from the settling tank to the Richardson oil filter on the engine room floor. The other end of the pump takes the clean oil from the filter and returns it to the engine. An overflow stand is provided on each engine. All excess oil at sight feed is returned to the clean oil chamber in the filter.

As the ground upon which the plant is erected is a loose shale, the question as to foundations was a serious matter. The depth to bedrock was too great to permit excavation to solid ground, so a reinforced concrete mattress was devised upon which to set the engine piers. The mattress is shaped like an inverted cup, 66 ft. 6 in. wide, 102 ft. long, and 3 ft. thick. In addition there is a beading 12 in. deep and 12 in. wide all around the bottom edge. This beading tends to prevent any shifting of ground and renders the entire substructure monolithic and self contained. Twisted steel bars 1 in. square were used for reinforcement. There are two sets of these spaced 10 ft. apart transversely, and one set longitudinally 10 ft. apart.

The vertical reinforcement includes a series of 1-in. square twisted bars set 5 ft. apart, which are carried beyond the mattress into the foundations piers,

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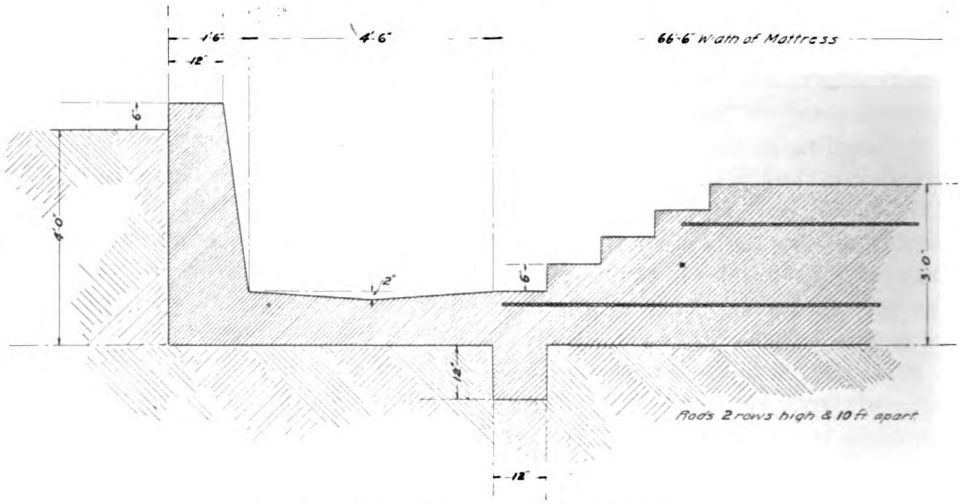

SECTION ELEVATION OF CONCRETE MATTRESS.

thus tying the entire concrete work firmly together. The foundation piers for the two high pressure compressors required 247 cu. yd. each, while the low pressure compressors and the mattress required 277 and 721 cu. yd. respectively. The mix was 1:2½:7 of cement, sand, and broken rock. All sand and broken rock had to be shipped in from a point near Bakersfield, as no suitable material was available on the ground. The building is steel frame throughout with galvanized corrugated steel sides and roof; the outside dimensions are 80 by 135 feet.

The method of starting the main engines is strikingly similar to that employed on Diesel engines, the auxiliaries performing the same functions as those employed on the Diesel motor vessel *Siam* that recently visited Pacific Coast ports. There are two electric generating sets, one of which is a standby. Each generating set comprises a 3-cylinder vertical natural gas engine with cylinders 15 by 15, 175 b-hp. at 257 r.p.m., made by Rathbun Jones Co. of Toledo, Ohio. To each engine is direct connected an Allis-Chalmers D. C. generator, 125-volt, 880-ampere. Each engine is also arranged to drive direct, by means of a friction clutch coupling, an Ingersoll-Rand class N.E.-2 tandem two-stage compressor 10¼ in. L.P. 4¾ in. H.P. by 8 in. stroke having a capacity of 83 cu. ft. of free air per minute to 200 lb. pressure. The generators supply electric energy for charging the storage batteries for engine ignition and for operating the water supply pumps, lighting the power houses and dwellings. The compressed air is delivered to three horizontal air receivers 3 by 15 ft. each in which compressed air is stored for starting the main and auxiliary engines. The storage battery outfit for ignition includes 40, 7-plate cells. The main engines use a mechanical make-and-break ignition taking current from a spark coil 40 volt and 5 amperes. The gas mixture consists of 12 parts of air to 1 of gas and may be adjusted to suit any variation in the calorific value of the natural gas.

The engines all have a centralized control from a floor stand placed just back of the engines and midway between the two sides. Valves on the floor stand control the compressed air inlet, gas inlet, spark, oil, and cooling

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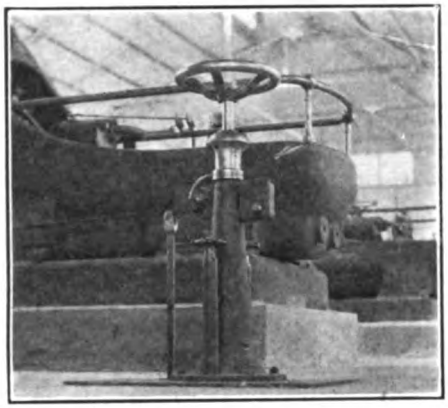


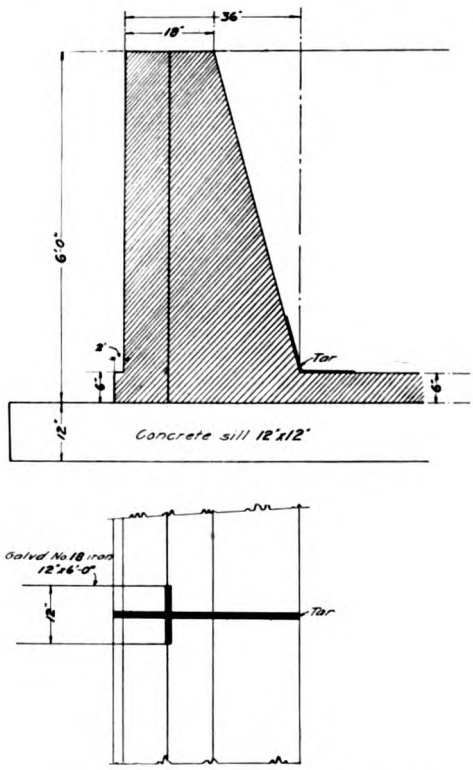
CENTRAL CONTROL FLOOR STAND.

water. An engine can be started from a state of rest and get up to full speed within about 10 seconds.

The arrangement of gas piping both to and from the compressor house is exceedingly well thought out and provides for every reasonable operating contingency. By a system of by-passes the natural gas after leaving the metering house may be led to any or all engines or may be cut out altogether and discharged direct into the main to Los Angeles and pass by the compressor station altogether. Practically all inlet and outlet mains are in duplicate, so that an accident to one simply means switching to the other so that service may not be interrupted.

The cooling water for jackets, intercooling between the high and low pressure compressors and also for aftercooling between the high pressure compressor and the gas main to Los Angeles is provided by two reinforced concrete cooling ponds. The smaller pond is 66 by 86 by 6 ft. deep. The walls are 18 in. thick at the top and 36 in. thick at the bottom. The floor is 6 in. thick and rests on reinforced concrete sills 12 in. square. Expansion, or rather contraction joints are placed in the walls every 22 feet. These joints are made of tar with a strip of No. 18 galvanized iron 12 in. wide and 6 ft. deep crossing it at right angles. This type of joint is used throughout on both ponds. This pond is used for cooling the compressor and engine jacket water and also for general fresh water storage.

The second cooling pond is 50 by 435 ft. by 2 ft. 8 in. deep, the depth of water ordinarily maintained being 18 in. In this pond are two series of cooling pipes, the first carrying the compressed gas between the low and high pressure compressors, and the second receiving the high pressure gas for cooling before it is delivered into the pipe-line to Los Angeles. The inter-cooler pipe coils consist of 6 lines of 6-in. diameter pipe 420 ft. long each, with steel headers. The after-cooler pipes comprise 12 lines of 6-in. diameter pipe 420 ft. long each with steel headers.



CONTRACTION JOINTS IN COOLING PONDS.

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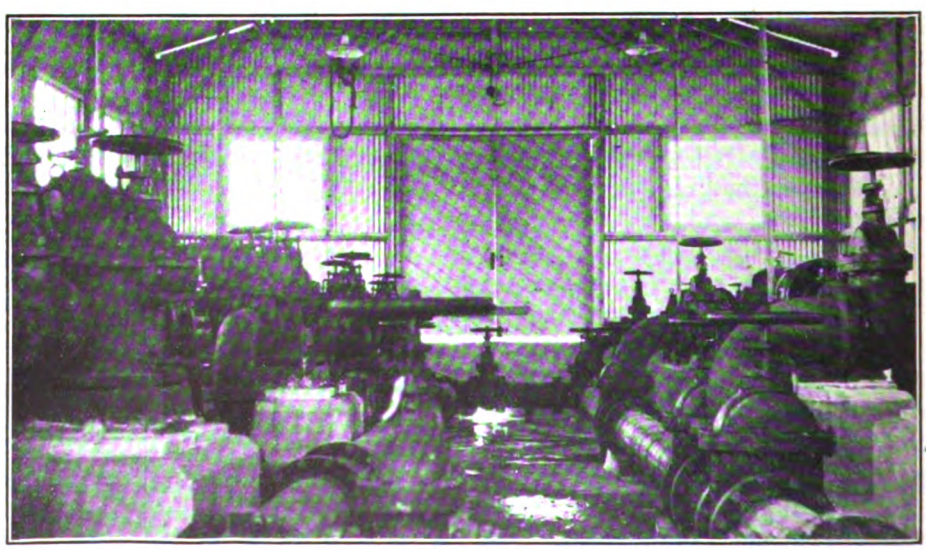
EXTERIOR OF PUMP HOUSE.

To cool the water a system of spray nozzles is used, and the water is sprayed through the nozzles into the atmosphere by means of centrifugal pumps, the water discharging again into the pond below.

The pumping system is worked out with the same care that characterizes the entire work. There are two 40-hp., 115-volt, 2000 r.p.m., D. C. motors, made by the C. & C. Electric & Mfg. Co. of Garwood, New Jersey. To these are direct connected two 6-in. Alberger volute pumps. These are utilized for cylinder jacket water supply. The water from the jackets flows by gravity to the cooling pond and is pumped to a 60,000-gal. wood tank, the total working head being 105 ft. There are also five more 6-in. Alberger volute pumps direct driven by 10-hp. Sprague D. C. 115-volt motors. These pumps are used for operating the water sprays in all the cooling ponds. The building is 25 ft. 4 in. by 46 ft., and like the other has a steel frame and galvanized corrugated iron sides and roof.

The source of water supply includes two wells. One of these is 730 ft. deep and produces about 175 bbl. of 42 gal. per hour. The second well is 360 ft. deep and produces 150 bbl. per hour. Natural gas under ordinary well pressure is taken from the mains and used for pumping by the Pohli air-lift system by which the water from the well is discharged into the separating chamber, where the gas and water are separated. The gas goes from there into



INTERIOR VIEW OF PUMPING PLANT.

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the 8-oz. fuel line to the engines and the water discharges by gravity into treating tanks from which it passes to the coolers.

The compressor plant as a whole is admirably designed and shows on every hand a thoroughness and attention to detail that can only come as a result of long experience. Plants of so high a type of construction are unusual in the oilfields and the fact that it has been built is an interesting indication of the belief of capitalists in the stability of the industry.

Regarded from any standpoint, this will compare favorably with power stations anywhere. There is no superfluous ornamentation, no attempt at decorative or artistic effects. The money has been expended where it was needed and nowhere else. It is strictly business everywhere, and one is impressed with the air of solidity and permanency given by the severely simple lines and the substantial manner in which the plant has been built.

This is the seventh plant of its kind that has been designed and built by George W. Schell, the others being in the Pennsylvania, Ohio, and West Virginia fields. With Mr. Schell in this work were J. C. Irvin, assistant; G. I. Gassdorf, draughtsman; and A. B. Paulson, the latter as erecting engineer for the C. & G. Cooper Co., who built the gas engines.

THERE are now at least four lines of railway in Bolivia on which construction is or soon will be carried forward. They are the Potosi-Sucre line, 90 miles; the Oruro-Cochabamba line, 130 miles; the Uyuni-La Quiaca line, approximately 167 miles; and the Machacamarca-Uncia line, approximately 31 miles. The completion of the Uyuni-La Quiaca line will link the Argentine railway system with that of Bolivia and southern Peru, and thus make it possible to travel from Buenos Aires to Mollendo entirely by rail except for the short trip across Lake Titicaca. Of the line between Uyuni and La Quiaca, the Antofagasta Railway Co. has constructed already about 56 miles and will build the rest of the line as far as Tupiza, 45 or 50 miles. The contract for the remaining section, about 62 miles, is still open, but an English and two French concerns are in the field for the contract, and one of these will probably do the work.

The contracts for the construction of the Potosi-Sucre line have not yet been let, but the citizens of the latter place are said to have raised about $500,000 to assist the Government in the work More than two-thirds of the line from Oruro to Cochabamba—that is, as far as Arque—has been built, and all the sub-contracts for the remaining sections have been let. The Machacamarca-Huanuni-Uncia line is a small-gauge line running through a rich mining region and belongs to Simon L. Patiño. The section from Machacamarca to Huanuni has been completed, and an American contractor, Chris Dillon, has received the contract to continue the railway to Uncia.

There are several short electric lines radiating out from Cochabamba, and these will probably be extended and increased in number.

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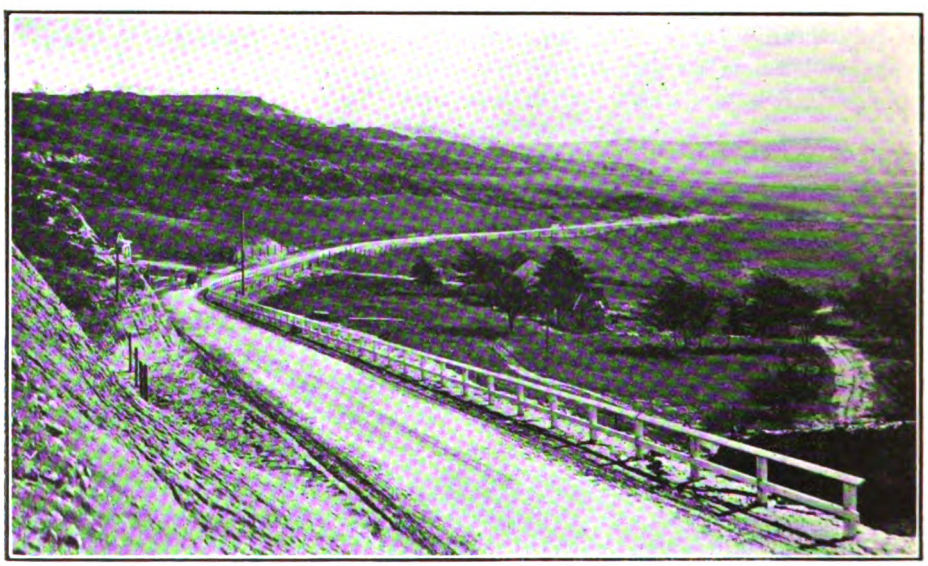
Some Problems and Accomplishments of the California Highway Commission*

By AUSTIN B. FLETCHER†

THE Supreme Court of California by its recent decision upholding the provisions of the Motor Vehicle Act of 1913 has solved one of the great problems which has confronted the Commission since its organization.



STATE HIGHWAY NEAR DEL MAR, SAN DIEGO COUNTY. PAVING 15 FT. WIDE, PORTLAND CEMENT CONCRETE BASE, THIN ASPHALTIC OIL TOP.

The State Highways Act under which the state roads are being constructed provides in no uncertain words that the state is to maintain the roads after they are built. The Motor Vehicle Act, through the fees which it specifies for the registration of motor vehicles, will provide the money, since one-half of the net receipts goes to the counties for the maintenance of county roads and the balance to the state highways for their upkeep. Estimating conservatively, there should be available from this source for the state highways during the year 1914 from $350,000 to $400,000. The law provides that the money shall be paid into a fund known as 'Motor Vehicle Fund' so that money not required in one year

*Read before the Commonwealth Club, March 14, 1914.

†Highway Engineer, Sacramento, California.

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may be used in the next.

The Commission is now studying plans for the organization of the maintenance work. It is probable that instead of establishing a separate maintenance bureau, the work will be placed directly in charge of the division engineers, who oversee the construction of the state highway in the seven divisions of the state. One or more squads of men, under a superintendent, equipped with an outfit adapted to all sorts of repair work, will do the work in each division. Such an arrangement will permit of almost indefinite expansion as the needs develop in the future.

The chief immediate use which the Commission has for a maintenance fund is for placing gravel or macadam shoulders along the paved portions of the roads built and to be built. In many localities the natural soil under and beside the paved portion of the roadway is not sufficiently stable during wet weather to sustain even the occasional wheel which gets upon it, and it is of course necessary that at times the shoulders of the roads should be able to carry some traffic.

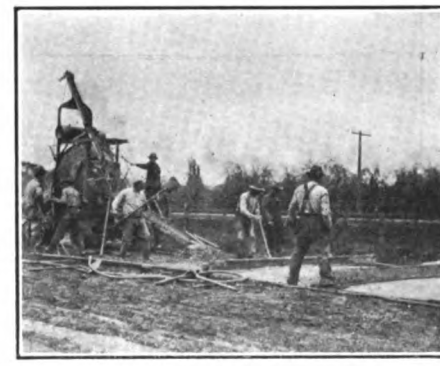
It did not seem possible to provide for such shoulders in the original construction because of the cost of such work and the necessity for conserving as much as possible of the $18,000,000 appropriated for construction purposes. The maintenance fund also permits of the purchase of equipment for repairing and maintaining the roads, which is costly and which cannot be rented economically.

Maintenance problems and those of construction, in highway work particularly, are almost inseparable, and in choosing a type of road or pavement the future must always be reckoned with. The greatest problem of all confronting the California Highway Commission is how to build nearly 2700 miles of state highway with $18,000,000 in such a manner that the people will be reasonably satisfied and so that the roads will not cost excessively for maintenance. This means that on the average, including administration expenses, the roads must not cost more than $6600 per mile, which is obviously too little if the whole system is to be paved.

As a result of much deliberation the Commission adopted as a standard type of paving to meet the average conditions a portland cement concrete roadway 15 ft. wide protected by a thin surfacing of asphaltic oil combined with stone screenings. This does not mean that all of the state roads are to be so constructed, for some of the roads have already been paved to a width of 24 ft. where the traffic seemed to require it, and surfaced with asphaltic concrete. Nor does it mean that all of the roads will be paved, for in some of the mountain counties such a treatment would be absurd under present traffic conditions.

There are now under contract about 315 miles of concrete road on which the thin top is to be placed. About fifty miles of the thin top has been put on and on all but a very few miles it is giving admirable service.

The history of the thin top or carpet



CONCRETE MIXER ON STATE HIGHWAY.

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is interesting. For many years, and until about the year 1906, the broken stone road, first developed in England by John L. Macadam, and perfected for American requirements by William E. McClintock of Massachusetts, was considered the last word in rural road building. The eastern states were all constructing their state highways of that type and the road-builders were a self-satisfied lot. In 1906 the writer was chosen by the Government Office of Public Roads to prepare a bulletin on the subject and he well remembers his feeling of pride when he was told that over 200,000 copies of his bulletin were to be printed and distributed. Such an issue was surely in the class of the 'best sellers'.

The writer also well remembers that but two years later at a road meeting at Buffalo he was obliged to confess that "the macadam road is a thing of the past" because of the ubiquitous automobile.

The case, however, turned out to be not so bad as was then predicted, for after experimenting with applications of hot asphaltic oil or refined tars and sand spread upon the cleaned macadam roadways, a method which the French probably first discovered, it was found that a thin bituminous carpet from ¼ to ½ in. thickness was developed, which served to prevent the ravelling of the stones composing the pavement.

There are thousands of miles of macadam road in the eastern states treated in this manner which are now giving ample satisfaction even to that most captious critic, the automobile owner.

In the year 1908 almost simultaneously in Ann Arbor, Michigan, and in Spencer, Massachusetts, sections of concrete roadway were covered with a similar bituminous carpet of refined tar and stone screenings. In the Massachusetts case, with which the writer is more familiar since the work was done under his direction, the bituminous covering was applied to lessen the roughness of a section of concrete pavement built by the Hassam process.

STATE HIGHWAY BETWEEN MOUNTAIN VIEW AND SUNNYVALE, SANTA CLARA COUNTY. PAVING 20 FT. WIDE, PORTLAND CEMENT BASE, WITH THIN ASPHALTIC OIL TOP.

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METHOD OF FINISHING CONCRETE.

Both the Ann Arbor experiment and that in Massachusetts were successful and the carpets gave good service, lasting two years and more with almost no expense until it came time to renew them by precisely similar applications of tar and screenings.

Within the last few years many thousands of square yards of concrete have been so covered with bituminous carpets, and the Ann Arbor engineer who thought out the scheme has even applied for letters patent on the process. The patent has not been granted yet so far as the writer is aware.

It was these experiments in the eastern states which led the California Highway Commission to consider the bituminous carpets for the California roads. The only essential difference between the work in the east and that here lies in the use of heavy asphaltic oil instead of tar.

It was not possible to use coal tar in California without long railroad carriage and correspondingly high cost, for it is not produced here in any considerable quantity. The writer, however, has no regret on that account. The bituminous carpets, using California asphaltic oil on 90% of the work already done, are far superior in his judgment to the tar and screening carpets of the east which he has inspected. They are also far superior to the bituminous carpets usually applied to the macadam roads in the east, and he asserts after more than twenty years' experience in state highway work that no eastern state is today getting its state highways constructed so cheaply, so thoroughly or surfaced so satisfactorily as is California.

Two trips made by the writer to England and France during the past five years have convinced him also that in the construction of our roads we can learn little there. They are still laying the bituminous carpets on waterbound macadam roads, or where the traffic is heavy, mixing tar with slag or broken stone and forming a crude bituminous macadam road crust, not nearly so good, in the writer's opinion, as the asphaltic concrete work done in California. As to maintenance problems, that is another story.

California started late with its state highways. Its people, with the changed conditions of traffic brought about by the automobile, are demanding what to all intents and purposes is city street work out in the country. And California is getting it, to all intents and purposes.

The Commission has had some poor work foisted upon it. In Sonoma county there is some concrete thinner than called for by the specifications but this has not been paid for and the poor work will be done over before the road is completed.

In Santa Clara county the writer made the error of allowing some asphaltic oil of too heavy a grade to be used, which, because of the climatic conditions at the time of its application, did not make the bituminous carpet of the thickness and quality desired or expected. This fault also will be corrected in a few weeks.

Based upon these instances the re-

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port has been circulated widely that the state highways are crumbling; that they are going to pieces; that they are a laughing stock. Almost any expression of contempt has served. It has even been said—God save the mark—that they have been hastily built. Mark Twain said somewhere—"The chief difference between a cat and a lie is that the cat has only nine lives."

The people on the Peninsula do not believe such nonsense, nor do the people in the San Joaquin valley, nor in Los Angeles county, nor in San Diego.

Nor indeed do the people of the state generally, or their actions belie their deeds. They believe in the kind of roads the Commission is building to such an extent that since October 1912 they have financed the construction by purchasing state highway bonds to the extent of nearly $7,000,000.

This leads to the discussion of another problem; the state highway work is full of problems. Since October, 1912, at which time by hook and crook about $2,000,000 of the state highway bonds had been forced upon an unwilling market, the bonds have not been salable at par. They pay but 4% and that has not been sufficient to make them interesting to the plutocrats who in these days have money to invest.

The Commission's engineers had been working since March, 1912, making the surveys, plans and estimates, but after the $2,000,000 was tied up by contracts entered into, it seemed that the work would have to stop.

At this point the Commissioners did what I suppose no other public board ever had to do. They began a campaign to get the counties and county banks to buy the bonds with the understanding that the proceeds of all bonds so purchased would be used in the purchaser's locality.

The legislature of 1913 enacted a law providing for the payment of a bonus sufficient to make several millions available but this act the Governor did not sign, presumably because he believed that the people were sufficiently interested in securing the highways to see that the bonds were sold. In this he showed his usual astuteness, for with the help of an act which permits the counties to invest their surplus funds in certain designated state, county and municipal certificates of indebtedness, the Commissioners have induced the counties to purchase, as before stated, nearly $7,000,000. And more is coming. Such a performance could not and should not have been expected of your highway commissioners, but they have done it.

The highway work has been a perpetual conservation of everything but energy. To conserve the $18,000,000, the mileage of state highway must be kept as closely as possible to the absolute requirements of the State Highways Act.

In the language of the Commission's attorney:

"The Act, undoubtedly, contemplates, first, the construction of two main or trunk roads, one along the coast and the other traversing the Sacramento and San Joaquin valleys; and, second, that the county seats of such counties as lie east and west of the trunk lines shall be connected to the trunk lines by lateral and tributary highways.

"The object of the statute, in so far as the two trunk lines are concerned, is by directness to afford a means of communication so that the people of the north may be in touch with the people of the south in the shortest interval of time and space, and at the same time linking together those county seats and centres of population which can practicably, and without materially sacrificing directness, be so joined in a trunk line running north and south through the state.

"The laterals are provided for in the 'State Highways' Act for the express pur-

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pose of furnishing ingress and egress to and from the trunk lines for such county seats as can not practicably be reached by a direct trunk line; and the ultimate scheme of the state highway system is to cover the state of California with a network of highways which will compact the whole state for the purpose of intercommunication of the residents of every part of the state, and so that no longer will counties be spoken of as being 'remote or inaccessible'.

"The state highway of California, under the present legislation at least, will be but the skeleton for the road system of the state, and local county needs must be supplied by county systems."

The Commission has had some difficulty in making the people of some localities believe that the law means what it so plainly says. Many hearings have been given and much time consumed in listening to advocates for particular routes who wished the course of the state highway diverted from what the Commission considered to be the most direct and practicable lines.

It is believed that the people of the state have now come to a better understanding of this matter and realize that the state highway is to be built for all of the people and that it cannot be diverted from its course for purely local requirements.

Perhaps the most notable 'route controversy', as these somewhat acrid discussions came to be called, and the most illustrative, was the case of Tehachapi *v.* Tejon. There the problem was to secure the most direct and practicable route between Bakersfield and Los Angeles. The Commission favored the Tejon Pass route and its continuation *via* the so-called Castaic ridge to Newhall. The Tehachapi advocates argued earnestly for a line through the Tehachapi pass, thence *via* Mojave and Palmdale to Saugus.

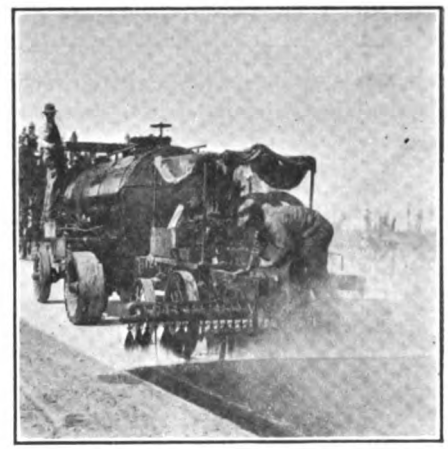
The two passes are of approximately the same elevation and it is possible to construct the state highway over either route with grades not exceeding 6% maximum. Both routes have some miles of difficult construction. But the controlling feature is that by way of the Tejon pass one may go from Bakersfield to Los Angeles in 115 miles, while the shortest route which is available now between the two places is 186 miles.

Some day when the road over the Castaic ridge and through the Tejon pass is completed and the magnificent scenery of this region is on view, thousands will sing the praises of the poor engineers who have so patiently worked out the scheme and made this route possible.

The writer in closing feels that it is but fair to recite briefly some of the other achievements of the Commissioners in the promotion of the state highway work, for which he thinks that they are entitled to the everlasting thanks of the people of California.

They have brought about the policy that the counties shall furnish without cost to the state all land needed for the right of way of the state highway.

They have induced the counties to build and pay for all bridges exceeding 20 ft. in span that will be constructed



APPLYING ASPHALTIC OIL TO CONCRETE BY PRESSURE DISTRIBUTER.

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along the line of the state highway.

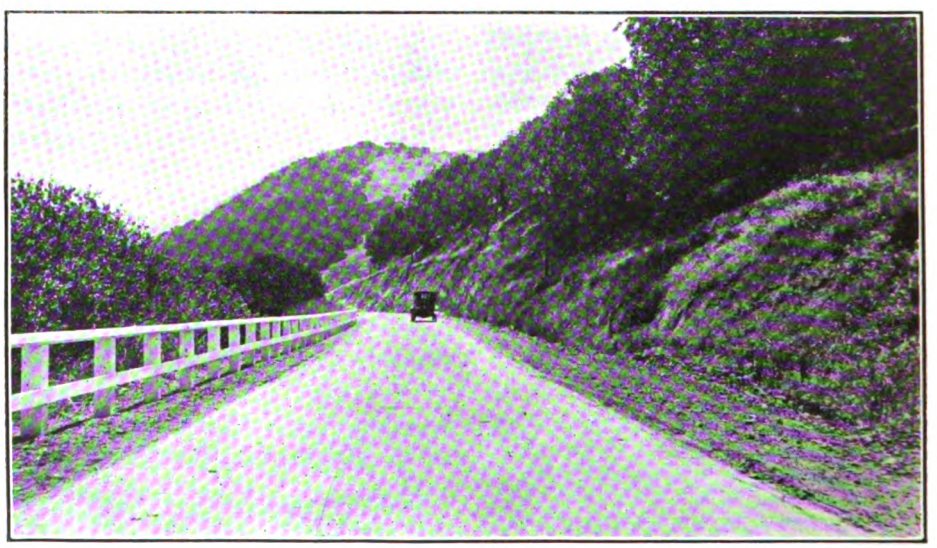
They have caused the cities and incorporated towns along the route to agree that the streets within their corporate limits should be paved and maintained by the municipalities.

They have induced the railroads over which hundreds of thousands of tons of materials must be transported to reduce their freight charges so that such materials will be moved at approximately one-half rate.

They have saved many thousands of dollars by purchasing road materials in large quantities.

They have by careful studies of the location of the state highway obviated crossings with railroads at grade in many places. In Ventura county alone within a length of 12 miles, nine grade crossings will be abolished.

They have provided for two trunk lines between San Francisco and Los Angeles, one by the coast and the other by the valleys, the first requiring about 384 miles of construction and the latter 323 miles, which will be paved and which will nowhere have a grade in excess of 6½% and not more than two or three miles in excess of 6 per cent.



COMPLETED STATE HIGHWAY, LOS ANGELES COUNTY ROAD. PORTLAND CEMENT CONCRETE BASE WITH THIN ASPHALTIC TOP. WIDTH OF PAVING, 15 FEET.

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Rationale of Bridge Design*

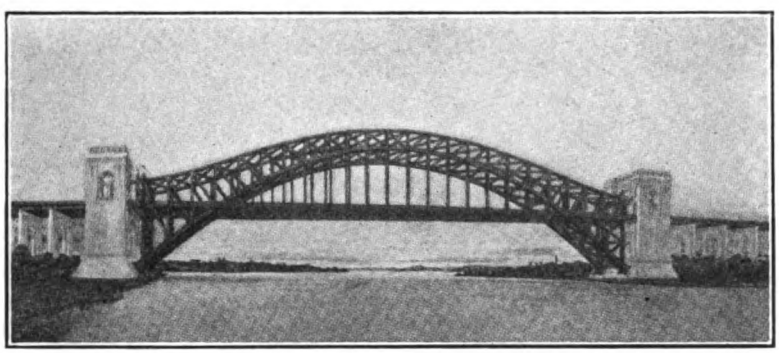
By CHARLES EVAN FOWLER†

THE designing of a bridge structure is not merely a matter of figuring the stresses, fixing the sizes of materials, and making a set of drawings. This may all be completed and a design result, but not the design suitable to the location, not such as it should be architecturally, nor for the traffic the structure will carry.

The true design to adopt must come very largely as an inspiration to the designer, who must have the necessary talent or imagination to conceive a bridge that will be the most appropriate and harmonious for a given location and for the existing or future surroundings.

The tower bridge in London, considered by many writers to be a monstrosity, was conceived by the engineer, Sir John Wolf-Barry, to harmonize with the surroundings, and particularly with the old Tower of London in the immediate vicinity. When considered in this light, it is an appropriate and harmonious design; the medieval towers are monumental and the steel work graceful.

The great suspension bridges of New York City are of the same class and are mostly in harmony with the towering buildings in the adjacent territory. The details, however, are not always carried out in the proper spirit, the towers of the Roebling bridge having never been completed and are thus lacking as truly monumental or architectural features; the towers of the nearby Manhattan bridge are too light to harmonize with those of the Roebling bridge or the nearby buildings, although considered alone it is a complete and pleasing design; the Williamsburg bridge is entirely lacking in architectural features, is out of harmony with the present or probable fu-



LINDENTHAL ARCH, HELL GATE, NEW YORK.

*Read before Pacific Northwest Society of Engineers, February 1914.

†M. Am. Soc. C. E., M. Can. Soc. C. E., Past Pres. Pac. N. W. Soc. Engineers.

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ture surroundings, and is only notable in design by reason of its magnitude and the graceful sweep of its cables.

The great arch at Hell Gate, over East river in New York City, is with its 1000-ft. span and carefully designed abutment towers a truly monumental structure, and the abutment towers are well designed and appropriate; the great arch demanding this mass for backing to properly satisfy the impression of a great thrust properly cared for or resisted.

The Washington bridge across the Harlem, one of the great bridges of the world, is wonderful in its architectural detail, but lacking in the great essentials for a work of architecture. The main structure consists of two spans instead of three, thus giving a pier in the middle; and the approaches are not balanced, thus causing the structure to lack in symmetry. Some of the other designs for this structure, while more simple in detail, would have made a much better structure and a more pleasing one, as they possessed the fundamental features that are necessary to any real work of architecture, simplicity, symmetry, harmony, and proportion.

This is well illustrated by the Eads bridge at St. Louis, with its three great arch spans and appropriate approaches, and although the details of the structure are very simple, it is one of the most pleasing and dignified of the world's bridges.

The conception of a design depends upon no rules, but upon the inherent ability of the designer, limited as we shall hereafter see by certain theoretical and practical requirements. There may be conceived a number of designs for a given location of different types, any one of which would be appropriate and beautiful, but the final decision as to which one of these to adopt must be made on the basis of relative cost, the most economical being usually selected. On the other hand, the most economical should not always be selected, but the best design architecturally be adopted, especially where the difference in cost is not very large.

The cost, for example, of a four-span structure for a given crossing might be found to be somewhat less than for a three-span bridge, and yet it would be wise from an architectural standpoint to adopt the three-span design, as the risk of one more foundation in the river would be avoided, with a probable saving in cost, should difficulties be encountered, that would make the three-span structure the cheaper in the end. In other words, the four-span design would have to be very much cheaper than three spans to call for its adoption. The reason for adopting a three-span design in place of a two-span bridge, might, on the other hand, be based entirely on the architectural features, as the cost and risk of the three-span structure might be much the greatest.

There are, then, two considerations that govern in making a decision as to what design to adopt for any location, the architectural features and the economy of construction, which latter may well be discussed in full before considering the architecture of bridges, and entirely aside from the esthetics of the problem.

The reactions or loads on piers for various lengths of spans must first be determined in order that foundations, abutments, and piers may be designed and the costs determined as factors in the cost of complete structures with different numbers of spans. The load on the pier and the weight of the pier having been determined, the size of the base of the pier may be arrived at by using the formula for the allowable

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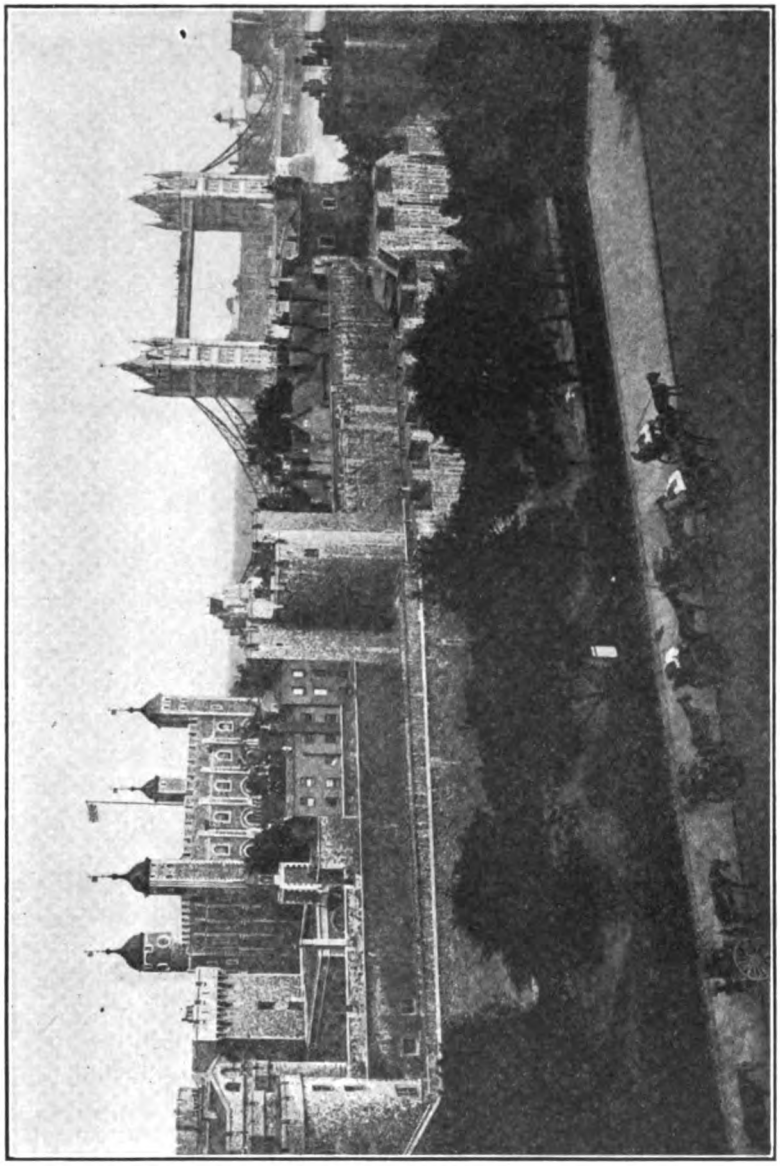
pressure on the foundation bed, as given in the writer's treatise on 'Sub-Aqueous Foundations,' the character of the foundation bed having been determined previously by careful core borings. Several trials may be necessary before the proper size of a pier is determined, and then careful calculations as to the stability of the pier must be made, and should it be found deficient, as is often the case with deep trusses, or where bascule or lift spans are employed, then it must be increased in length of base until the maximum allowable stresses and pressures are not exceeded. The method of making these calculations is fully treated for the first time in Chapter XXV of the treatise above mentioned.



TOWER BRIDGE AND TOWER OF LONDON.

Then by means of the cost of abut-

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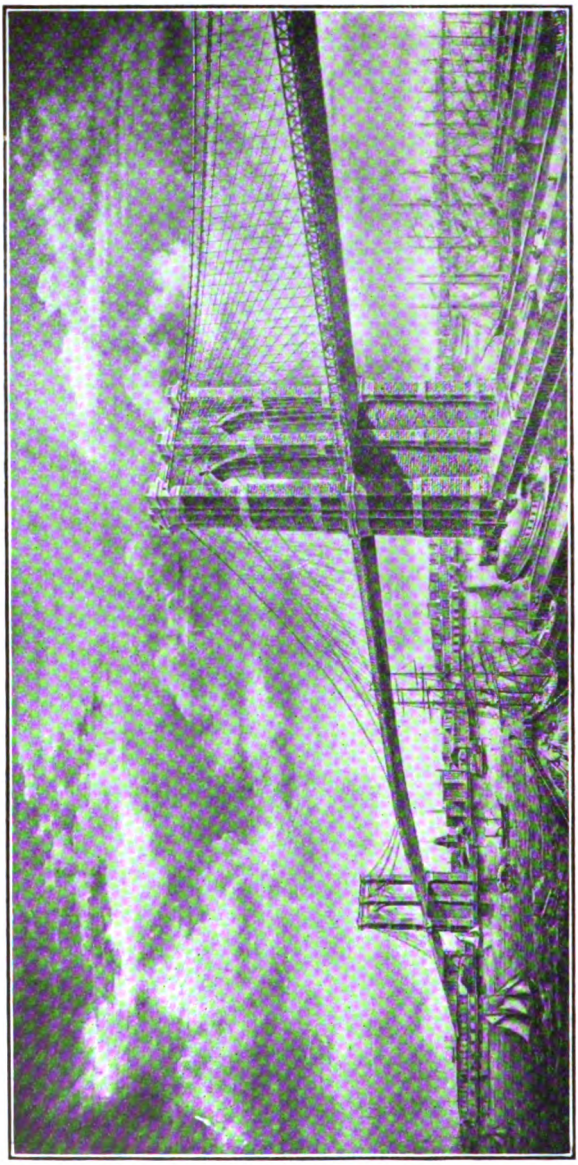

ROEBLING BRIDGE, EAST RIVER, NEW YORK CITY. ORIGINAL DESIGN.

ments, piers and spans, the relative costs of various designs may be determined; the weight of the spans to be calculated from reliable formulae or from actual stress and section diagrams. The whole process may be somewhat shortened by using the Ottewell formula given in the writer's treatise, or that given in Merriman's volume III. The design of the approaches may be a factor in the relative costs, and in such cases must be included in making the comparisons.

The fact that some consulting engineers make out certain designs to be the cheaper, when comparing them with other designs made up on an entirely different basis, both as to the character of the construction and the real factors of safety, should make any one

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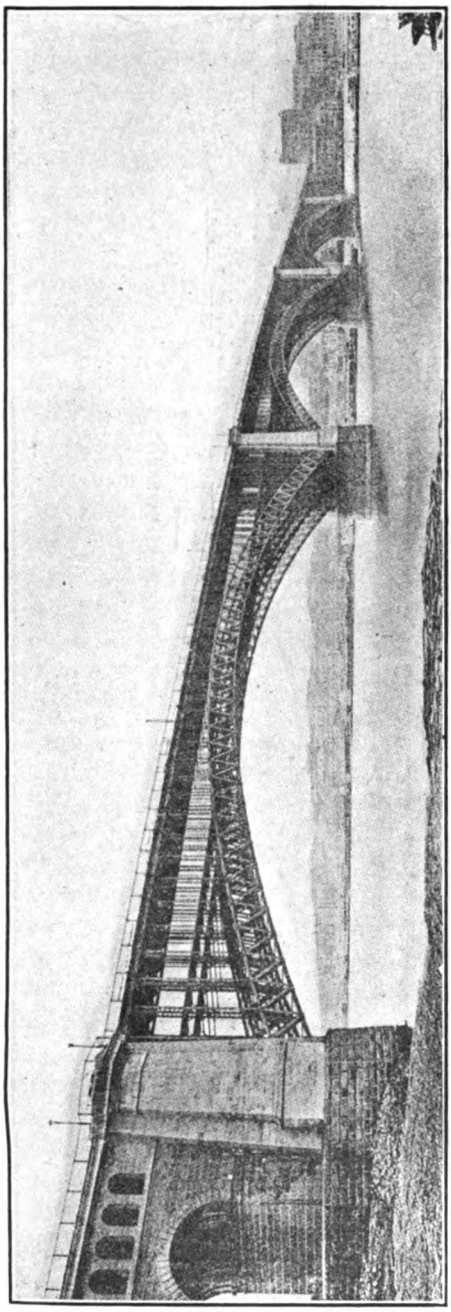

EAD'S BRIDGE, ST. LOUIS, MISSOURI.

suspicious of the character of the services offered and disbar such engineers from reputable practice.

The type and design of the superstructure is such a large factor in its cost that this must be fully decided upon before beginning any of the above investigations, and then all designs be compared upon a common basis. Where the grade is high above the stream, with plenty of clearance for floods and navigation, deck spans of some type are of course the most economical to employ. Where the bridge is high or falsework expensive for other reasons, it may be best and cheapest to use an arch or a cantilever design, and where very long spans are necessary, either the cantilever or suspension bridge must be used. Where the clearance for high water or navigation is limited, through trusses must be used, although it will often be best to use cantilever spans instead of simple trusses. Through arches or half-through arches may often be employed with good results both architecturally and economically.

The economical design of the superstructure of a bridge requires careful consideration as to the style of trussing, the panel length, and the truss depths. Longer panels and deeper trusses are more economical for modern heavy loads, but for plate and riveted lattice girders the depths are usually much less than for regular trusses. The span lengths for cantilever bridges should always be decided by careful mathematical analysis, as well as the lengths of the cantilever arms, suspended spans and depths. The height of towers and the depth of stiffening trusses for suspension bridges must also be carefully analyzed.

The design of movable spans should be carefully considered, not only with regard to first cost, but as to cost of operation and maintenance as well, but do not get the idea that revolving draw spans are out of date, for in many locations they are the cheapest and the best to employ. Then there are locations where bascule spans are the best from every point of view, but where

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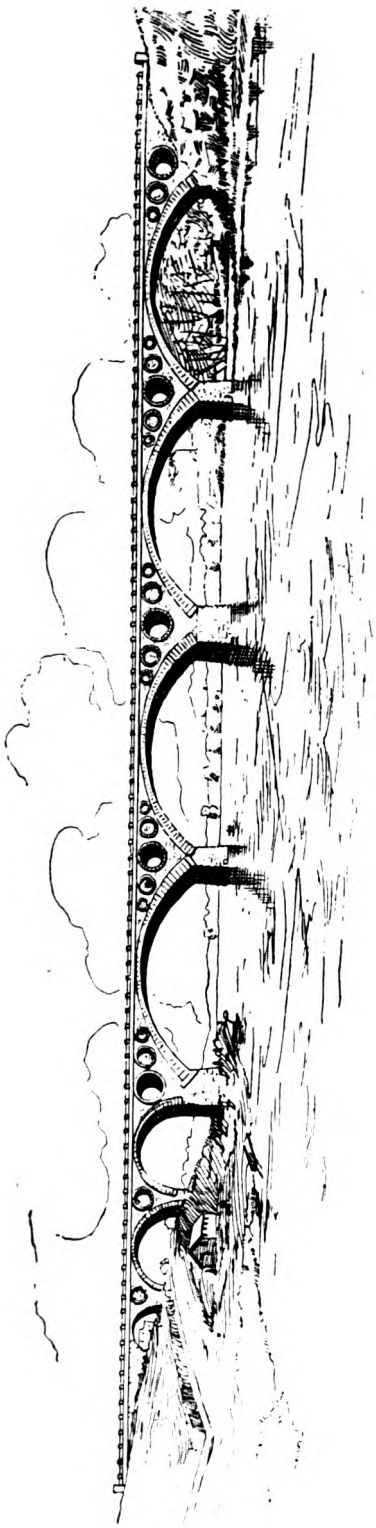
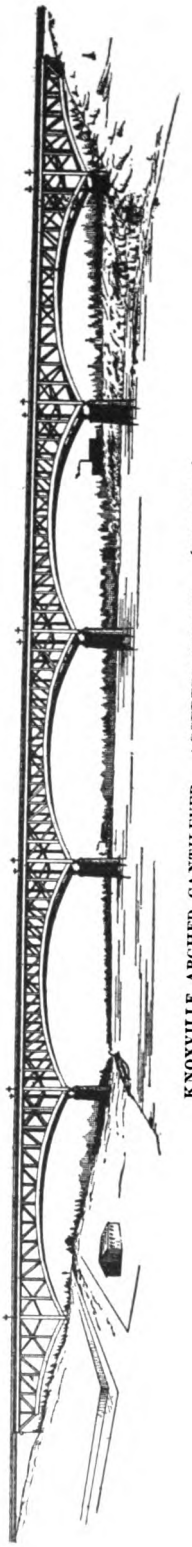


KNOXVILLE STONE BRIDGE DESIGN.



KNOXVILLE ARCHED CANTILEVER. ACCEPTED DESIGN. (FOWLER.)

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used they should harmonize with the remainder of the structure if there are additional spans, but in any case those forms must be abandoned that have no pretentions to architecture or beauty, and the same thing may be said with regard to other types of movable spans.

The details for ordinary spans have reached a practically permanent basis, so that standards, at least as to type, are usual. Where the structure is of unusul size like the Blackwell's Island bridge, the Forth bridge, or the Hell Gate arch, each member must be the subject of critical analysis and study.

Lack of such study and analysis was the cause of the failure of the first Quebec bridge, although the writer's one-time assistant, the late A. H. Heller, had fully covered the points in question in his book on 'Stresses in Structures.' Great suspension bridges, too, are of necessity special problems throughout and must be studied with greater care than any other type.

The floors of railway spans are usually of a standard type, either with steel stringers and ties or else a steel trough floor with ties laid on the ballast; but the types of floor and paving for highway bridges are so numerous that it is often a grave question what to adopt. The cheapest floor that should in any case be used on a good bridge is one having steel joists with spiking strips bolted to them, to which the floor plank is spiked. The very best floor is undoubtedly a reinforced concrete slab, with from 1½ to 2 in. of sheet asphalt surface, although it may be wise to use a creosoted block surface, the thin blocks being set directly in asphalt on the concrete and either filled with sand or grouted.

Having discussed those things which have to do directly with the economy of bridges, with masonry piers and steel superstructures, we may well discuss structures built entirely of stone or concrete, or of reinforced concrete. Such structures must be fully designed and a careful estimate of cost made in order to make any reliable comparisons. The cost of stone bridges is, of course, the greatest of any type that might be considered, and in the case of the Knoxville bridge where the cost of the arched cantilever was only $250,000, the bids for the stone arch design was about $1,500,000, thus making it out of the question to use stone where low first cost was a necessity. The same is true to a very great degree with concrete arches, but when reinforced concrete archs are considered, they may be designd to cost but slightly more in many instances than steel bridges, and should be carefully considered where a permanent and artistic structure is demanded.

The writer has for many years made a study of the architecture of bridges, and his book of 'Engineering Studies' was the first and only attempt that has been made to formulate any rules of architectural bridge design. It will be superfluous perhaps to say that the statement of an eminent engineer, in a recent report on a great bridge, that beauty could not be secured unless economy was sacrified, does not meet with agreement from the writer.

There are, it is true, no orders of architecture for bridges as for buildings, nor is there any classification of styles for particular ages possible, as in the case of building architecture, but basic rules must be observed, whether the design be for a building or for a bridge.

Simplicity, harmony, symmetry, and proportion must be regarded in any design that would have any pretentions to beauty or to architectural effect. They are the fundamentals of true architecture, no matter what the struc-

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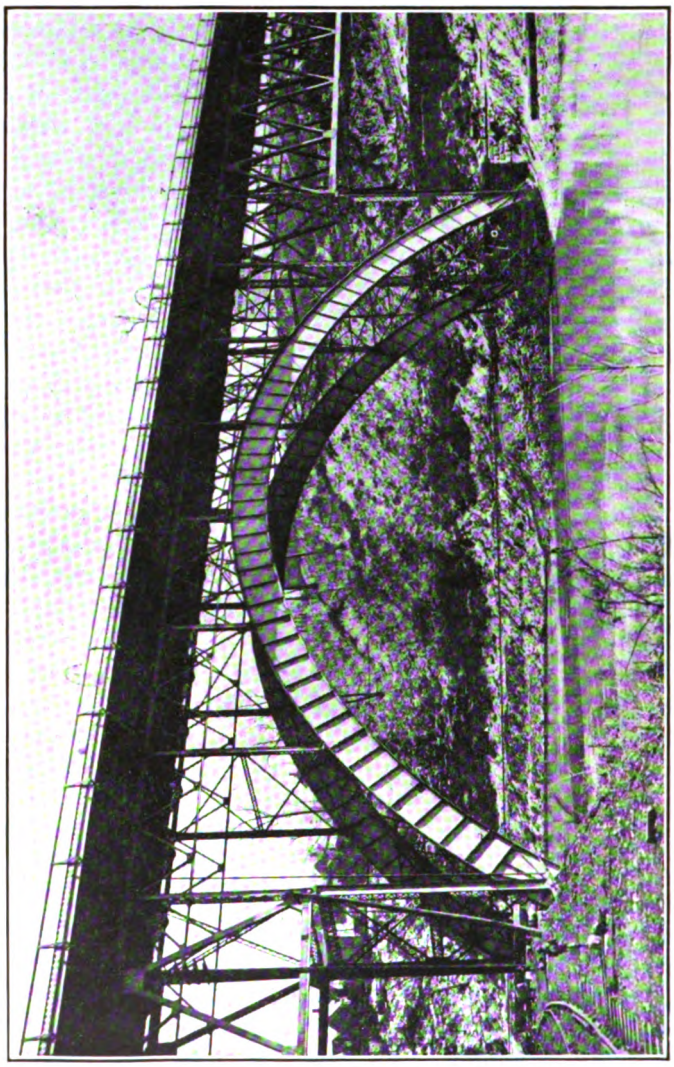

MARKET STREET ARCH, YOUNGSTOWN, OHIO.

ture may be to which thought is to be applied in its design.

Simplicity means first a truth-telling structure, no subterfuges about the lines of stress, no covering up of a concrete structure with a stone facing, no frivolous or inappropriate details, but a strict adherence to the necessary features, whether they are to carry the loads or to ornament the bridge.

Harmony is essential to a pleasing design, for without it the structure would be distasteful. Harmony not only as between substructure and superstructure, between the various spans, between the spans and the approaches, between the utilitarian features and the ornamental details, but with the surroundings.

Symmetry may or may not be essential to a pleasing design, although it usually is necessary if a truly architectural structure is to result. Where the bridge has a great length, unsymmetrical features are not so noticeable as in a shorter one which may be all

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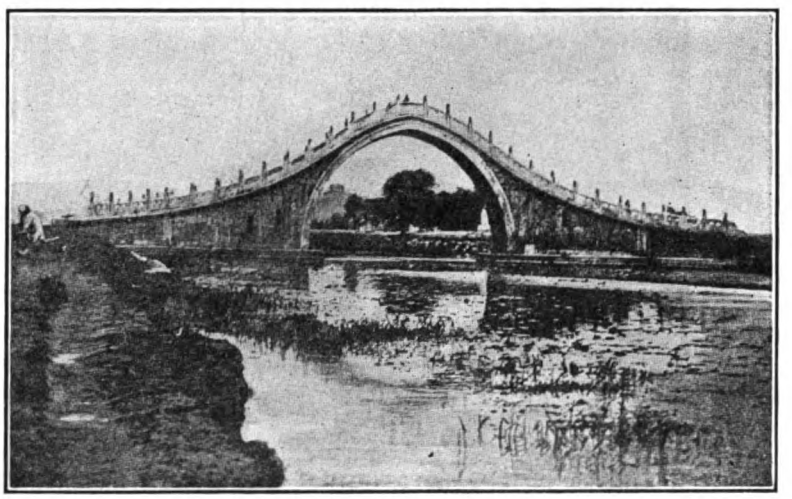
taken in at a glance. As is often true in a landscape, balance may frequently be secured by including an unsymmetrical feature. That is, where in one portion of a structure such as a draw or other unbalanced feature must be included that will destroy the symmetry, something must be introduced in the other portion to restore the balance, although symmetry does not result.

Proportion is necessary that the three preceding principles may be realized, and usually when the economical proportions have been determined, they are pleasing. However, in many cases modifications must be made to reach the point where economy and beauty can both be satisfied. Proportion of details employed for ornamentation is quite another thing, and to be harmonious they must have the proper balance.

Examples may be seen in every structure of the proper application of some of these principles, but more often we find one or the other flagrantly violated, so that the remark of C. Shaler Smith, that dean of American bridge engineers, to one of his assistants, should be well remembered by him who would reach high rank in his profession—"most bridges are examples of what not to do." Seldom, if ever, do we find a structure that complies with all of the fundamentals, although many bridges approach so nearly to the ideal that careful consideration and analysis are necessary to determine just where improvement could be effected.



CAMELBACK BRIDGE, PEKING, CHINA.

Simplicity is best illustrated in its pleasantest features by suspension bridges and arches with no decorations or embellishments of any kind. Harmony is best exhibited where no part of the structure seems to be extraneous and where the structure seems part of the surroundings. Symmetry in its simplest form is where one-half of the structure is exactly like the other. Proportion is most nearly reached when the structure is most pleasing and the truth expressed most accurately.

The basis for a real architectural system for bridges must come, of course, from building architecture and on

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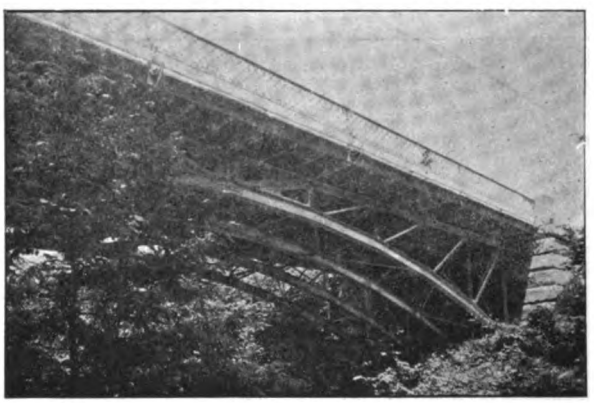
studying the columned or arched facades of buildings we find an uneven number of openings or arches are employed in the great majority of the world's notable and best pieces of architecture. Where there is an entrance it is nearly always in the centre, with one or more arches symmetrically disposed on either side.

Careful study and analysis of the examples of Egyptian, Roman, and mediaeval buildings discloses the fact that such an arrangement is most pleasing to the senses and where it has been violated the design is unpleasant. This, then, we may take as the starting point of any design, an opening instead of a pier at the centre, with the remainder of the structure arranged symmetrically on either side. Carried to its logical conclusion, where there is an approach it should have an uneven number of openings, and where there are spandrel arches employed in an arch bridge, they should be of an uneven number.

The Knoxville arched cantilever, designed by the writer was of five main spans and two anchor arms, thus giving an opening at the centre and a perfectly symmetrical structure, except that one abutment was longer than the other, but not apparent to the eye in a structure a third of a mile long. Economy was violated in the depth of the anchor spans in order to make the bridge harmonious, and the basic rules were all as nearly adhered to as is often the case.

The Market-Street arch at Youngstown, Ohio, designed by the writer, was a very difficult problem to solve on account of the side spans having to clear the railway tracks, and on account of the 4% grade of the roadway. The design, however, is symmetrical with the exception of the grade and the approaches, and was made quite harmonious by carrying the sub-trussing of the side spans through at the same elevation as the lattice truss over the arch.



MILL CREEK PARK ARCH, YOUNGSTOWN, OHIO.

The Mill Creek Park arch, while a short span, shows the possibility of designing artistic bridges for ordinary locations.

Comparing the Memphis bridge by Morison with the Thebes bridge by Modjeski, we can readily see how much is gained in architectural appearance by the symmetrical arrangement of the spans in the Thebes bridge. Comparing the approaches of the Thebes bridge

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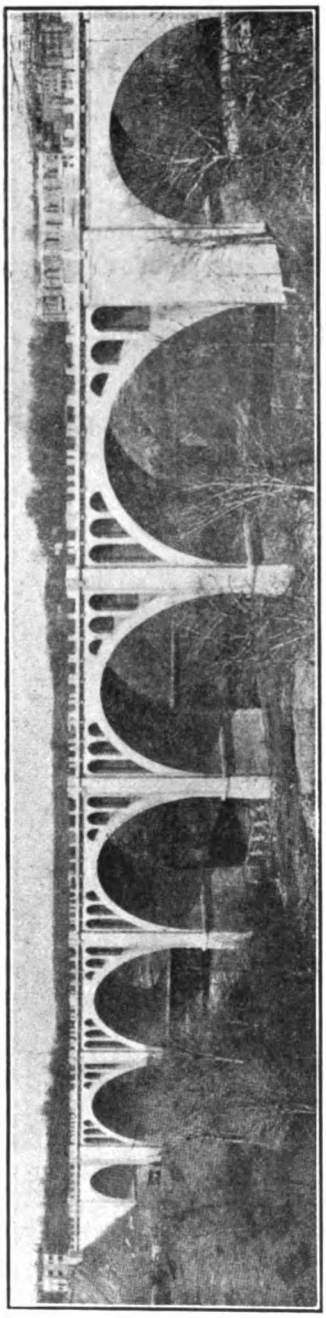

CONNECTICUT AVENUE BRIDGE, WASHINGTON, D. C.

with the approaches of the Forth bridge we see how much more in harmony with the main structure are the approaches of the Forth bridge than those of the Thebes bridge, although considered alone the latter are of the best design architecturally.

The Grosvenor Dee bridge, at Derby, England, with its 200-ft. masonry span, is one of the greatest bridges of the world, but the paneling of the abutments and spandrels, and indeed all the decorations, are so out of harmony with the great span, that they dwarf it and ruin the design. Compare this with similar details of the Eden Park, Cincinnati, reinforced concrete arch and we find such ornamentation entirely appropriate and harmonious for the smaller span.

European bridges are more often well designed architecturally than those of other countries and the great bridge over the Rhine at Bonn, Germany, is an example where simplicity, harmony, symmetry and proportion are all as fully met and satisfied as has ever been the case in any bridge structure.

The Camelback bridge in the Imperial Palace grounds at Peking, China, is also one of the most perfect of the world's bridges from the architectural point of view and satisfies the cardinal requirements of design.

The best design in the United States is the Connecticut Avenue bridge in Washington, D. C., with its five great concrete arches, and very little fault can be found with the design, except the inappropriate decoration of the wing walls of the abutments. The designing of harmonious and appropriate details in the proper proportion is a study in itself and entirely beyond the scope of this paper. Should designers however carefully observe the cardinal principles herein laid down much more pleasing structures would result and a great stride forward be made in bridge engineering and architecture.

The necessity for good construction, especially of foundations, is obvious.

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Gantner-Mattern Company Knitting Mill

By E. F. CYKLER*

SAN FRANCISCO can boast of the most complete and modern knitting mill in the world. The Gantner-Mattern company accomplished this when they built their new factory on Mission street between Tenth and Eleventh streets. Before beginning construction they thoroughly examined and discussed various types of construction, economical plant lay-outs, lighting, good and healthful environments for their employees, and other details that make their mill as it now stands.

The building is of reinforced-concrete construction throughout, practically six stories and basement high, and covering a ground area of 103 ft. frontage on Mission street and running through to Minna street, thereby giving a depth of 160 ft. The basement floor is 11 ft. below the first-floor level. The first story height is 19 ft. 1 in. from floor to floor. The second, third, fourth, and fifth story heights are 13 ft. 1 in., and the sun-room and cafeteria are 10 ft. above the roof.

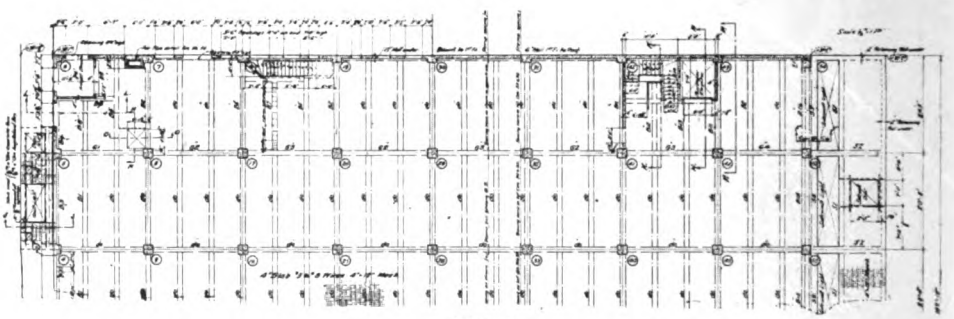

FIG. 1.

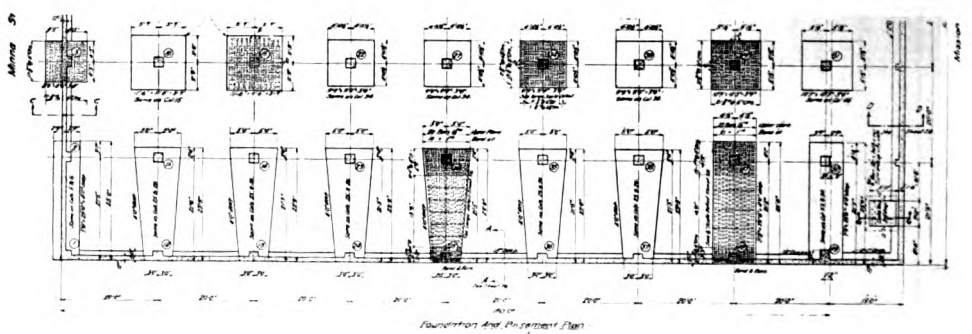

FIG. 2.

As light is a very important con-

*Assistant Engineer with H. J. Brunnier, Sharon Bdg., San Francisco.

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sideration on account of the various colors of threads and yarns, a great deal of study was given to get proper illumination. In the roof over the centre portion of the fifth floor, saw-tooth skylights were placed as shown in Fig. 9 and 10 and detailed in Fig. 4. Across the entire Minna street front and 80 ft. on the south side, the space between

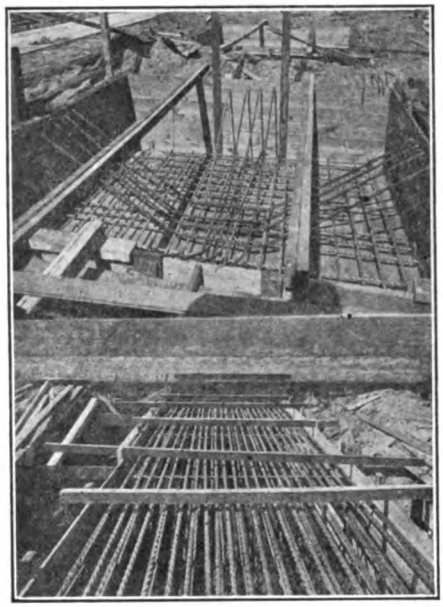

FIG. 3.

columns and floors was filled with metal sash and wire glass. The Mission-street end was made as open as architectural treatment would allow.

Materials used in manufacturing are brought from basement storage or from the street direct to knitting machines on the fifth floor by means of a large freight elevator. From this floor the products gradually work their way down by a series of chutes from floor to floor, being finished in stages as they go. They are marked and boxed ready for shipment on the third floor. The second floor is used for storage of articles which are made for future shipments. Part of the first floor is used by the shipping department while the balance is to be leased for stores.

A live load of 125 lb. per square foot was figured for all floors in addition to dead load, and on the roof 30 lb. per foot live load was allowed. The second to fifth floors have wood finish nailed to wood sleepers embedded in concrete. This allows them to locate and re-locate their machines in any place, as they are well balanced and can be easily held in place by lag screws let into the floor.

The soil was a good clean sand and a soil pressure of 6000 lb. per square foot was allowed for maximum dead and live load. All footings were proportioned to a uniform dead load. Fig. 2 shows a part plan of footings, some of which are detailed in Fig. 4. Fig. 3 is a photograph of construction of square and combined footings, showing steel held in place from above and also good spacing to allow free flow and bonding of concrete. The basement and walls are just good concrete and no waterproofing materials were added. During our heavy rains this winter there was no sign of moisture in the basement.

Fig. 1 shows part plan of first-floor framing and which is typical for the second, third, and fourth. Details of beams and girders and the disposal of reinforcement is shown in Fig. 5 and a photograph of same in Fig. 6. It will be noted that all reinforcement is supported in forms by bent stirrups. In the tops of beams fastened to the stirrups are two ⅜-in. square bars which hold the fabric in position over supports.

As the owners desired square panels in the fifth floor and roof, the Chew system was adopted. Details of construction are clearly shown in Fig. 5

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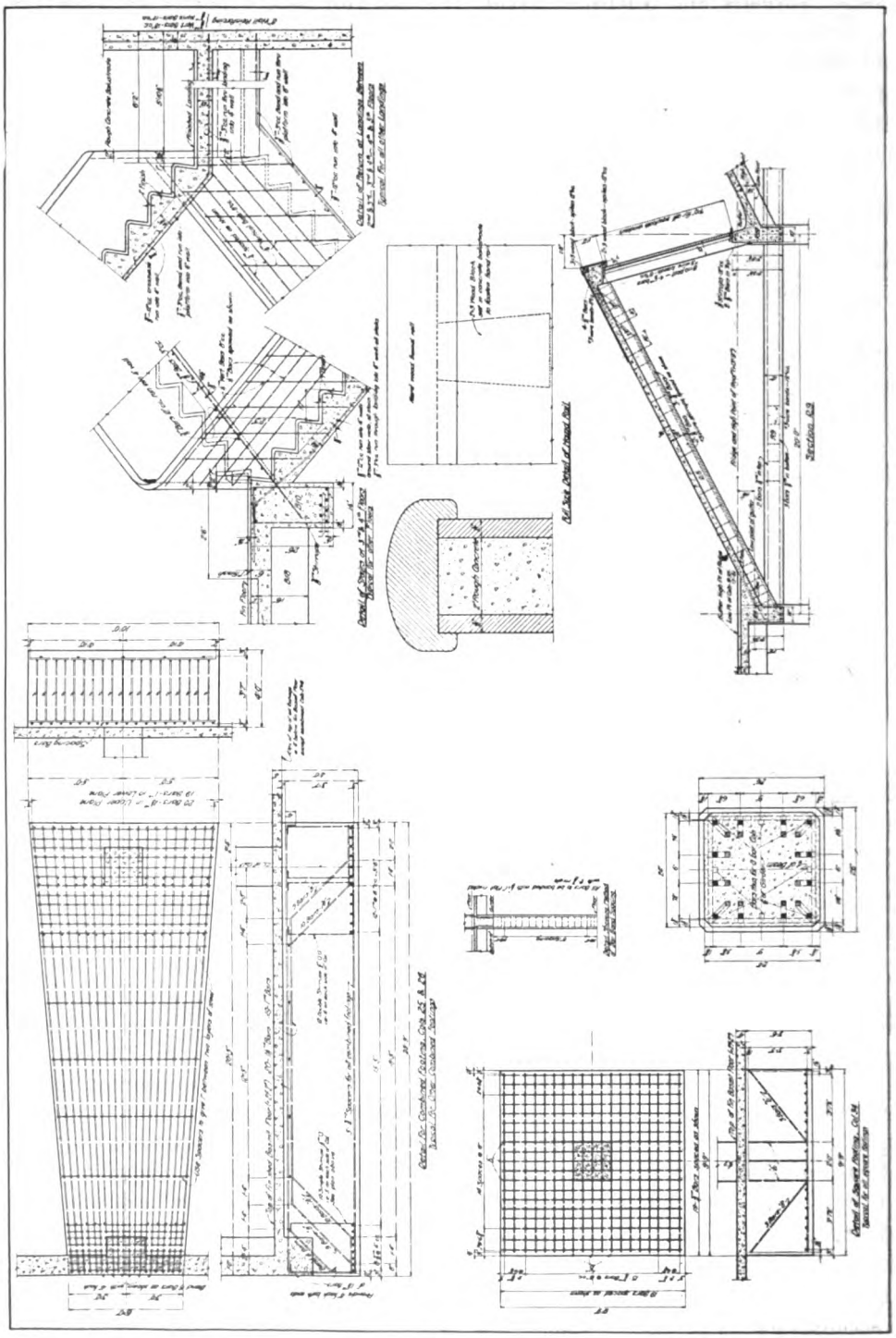

FIG. 4.

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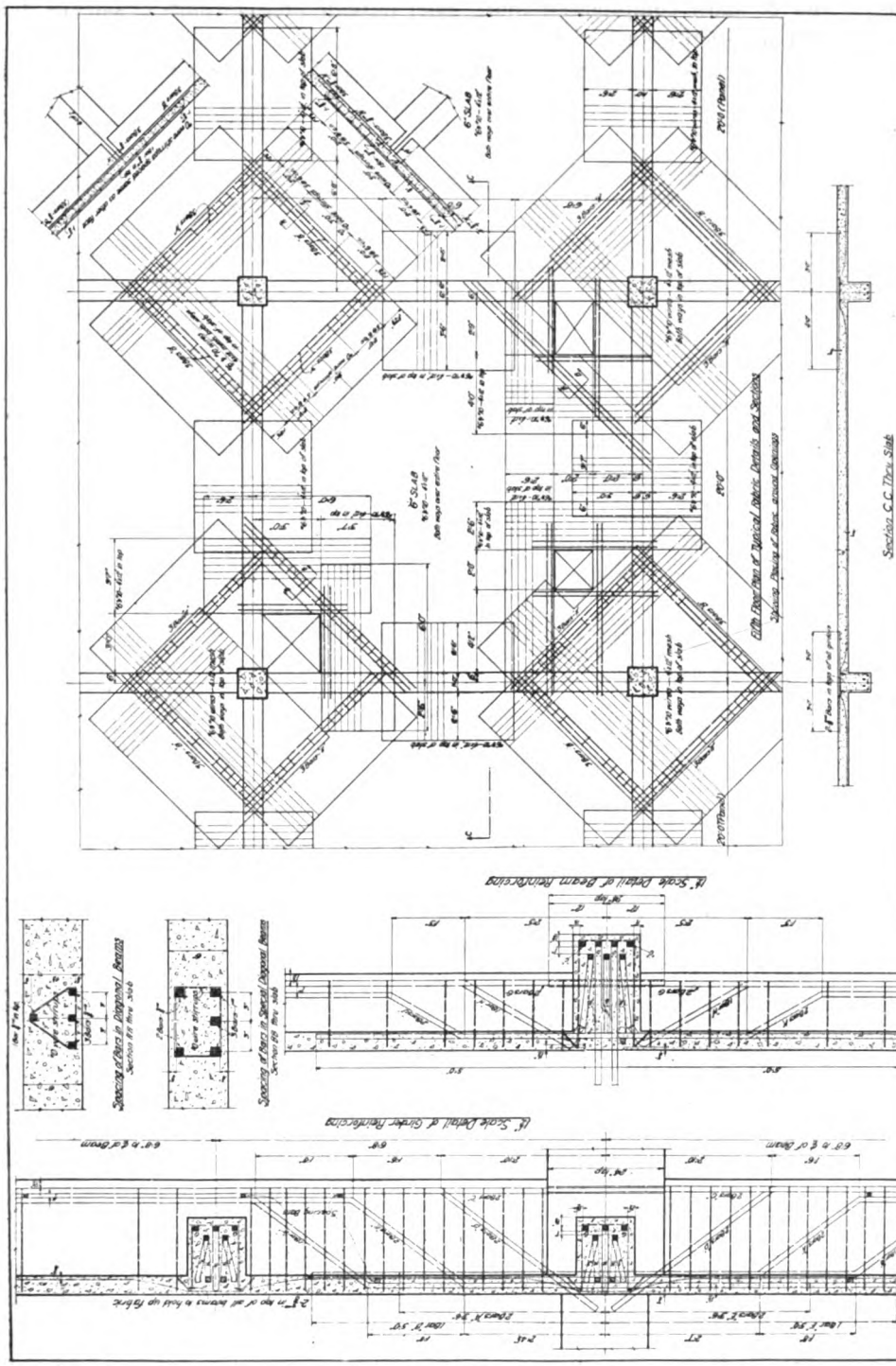

FIG. 5.

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and in photographs Fig. 7 and 10.

Fig. 9 and 10 show complicated roof framing with saw-tooth construction in central portion and sun-room framing on Mission-street front. The part of roof outside of saw-tooth is cement finished and nicely fitted up with plants, flowers, and benches where employees

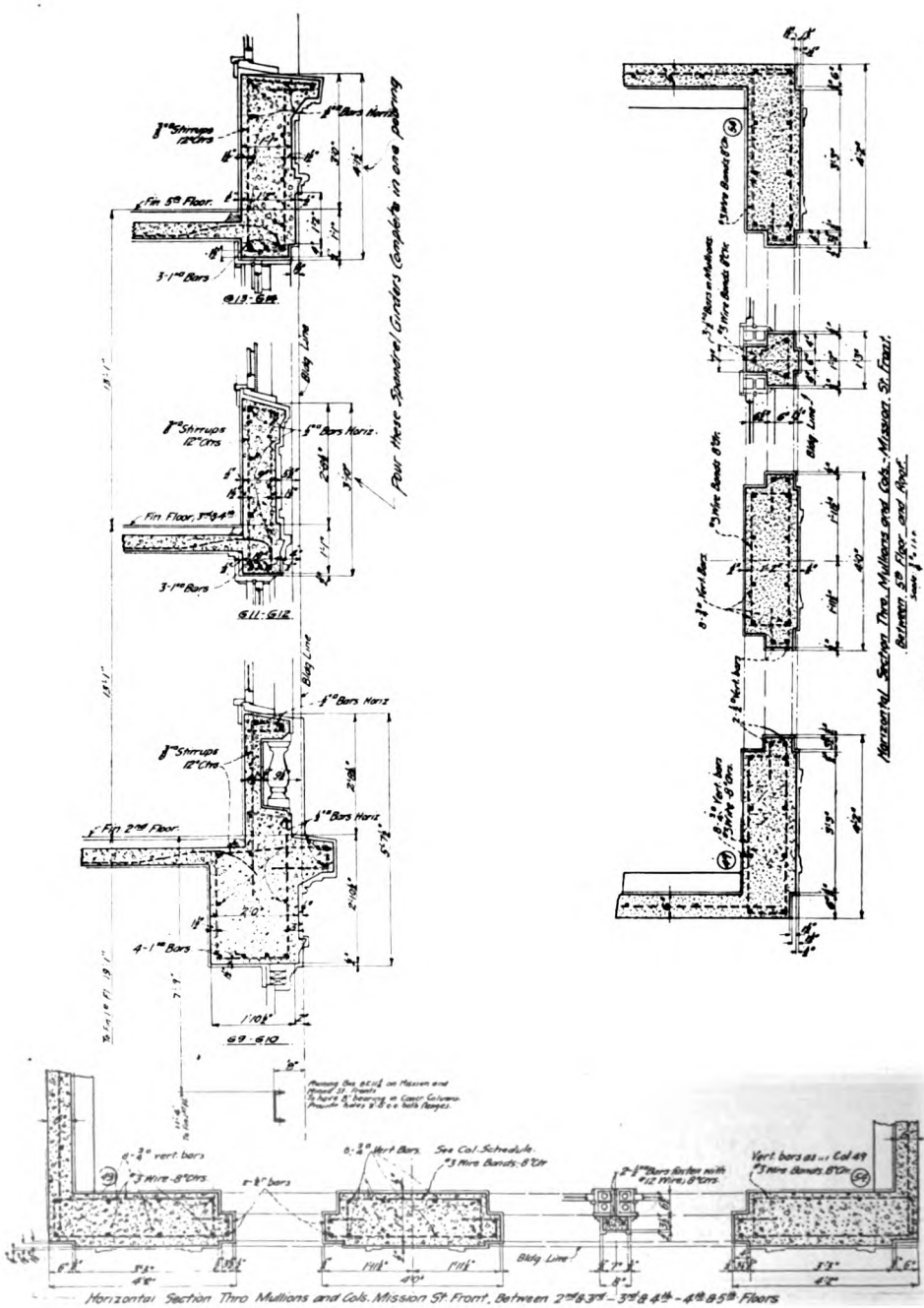

FIG. 8.

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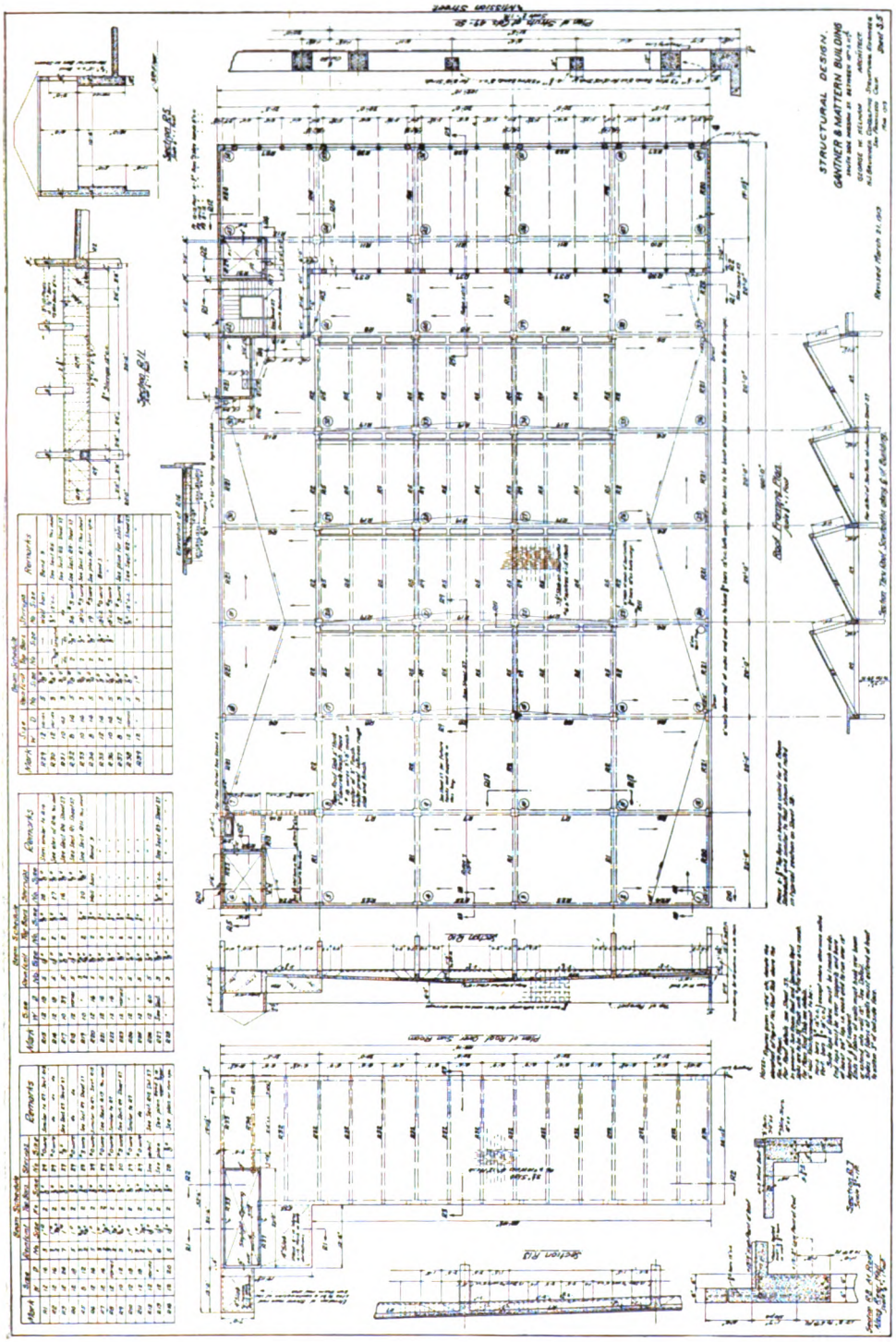

FIG. 9.

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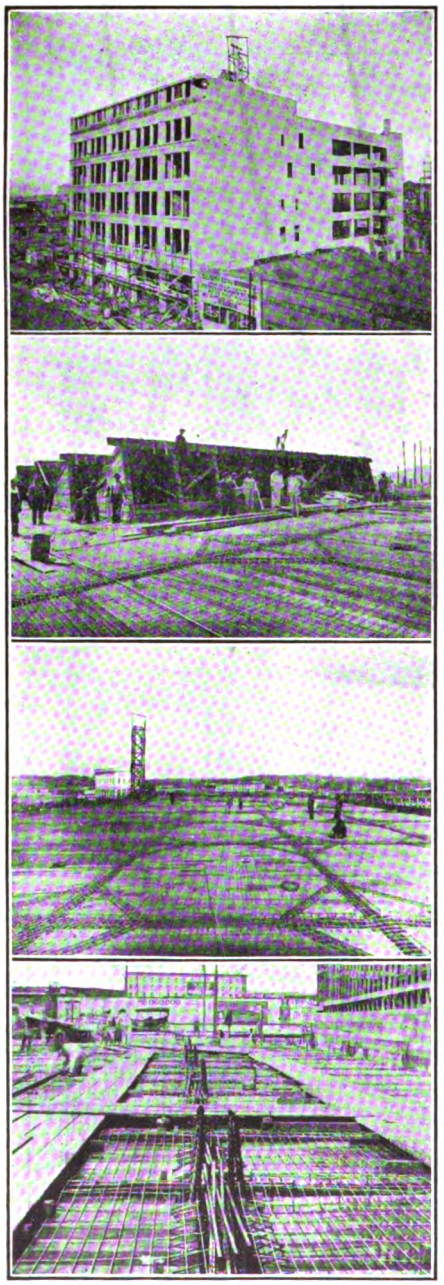

FIG. 11, 10, 7, AND 6.

rest during noon hour. In the sun-room there is a cafeteria run by the owners and lunches are sold to employees at no profit.

Fig. 8 shows details of spandrels and mullions on Mission street. The architectural pilasters were made use of as columns and the spandrels as beams. The building was made fireproof throughout, and special care was taken to keep fire from spreading on the inside as well as to keep it from getting in from the outside. The freight elevator is encased in concrete with wire-glass doors. The stairs, which are of reinforced concrete as shown in Fig. 4, and the passenger elevator are enclosed in concrete walls with metal doors, so as to prevent fire and smoke from traveling from floor to floor. All partitions are of terra cotta tile or 4-in. concrete walls. The exterior walls are 6 in. thick, the fire wall running 5 ft. above the roof to protect the promenade from the prevailing winds.

The concrete was made of 1 part cement, 1½ parts ocean-shore sand, ½ part fine sand, and 4 parts gravel. All cement and concrete was carefully tested. The concrete specimens for crushing were made in tins 6 in. diameter and 8 in. high. These samples were taken frequently during construction, and compressed at an age of 28 days. They developed an average strength of 2200 lb. per square inch.

Santa Cruz portland cement was used throughout. Lindgren & Co. were general constructors. Geo. W. Kelham was the architect and H. J. Brunnier structural engineer.

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The Engineering Digest

California Electric Railways

PRELIMINARY figures of the forthcoming quinquennial report on the electric railways of the state of California have been given out by W. J. Harris, Director of the Bureau of the Census, Department of Commerce. They were prepared under the supervision of W. M. Steuart, chief statistician for manufactures.

The statistics relate to the years ending December 31 for 1912 and 1907, and June 30 for 1902. The totals include electric light plants operated in connection with electric railways and not separable therefrom, but do not include reports of mixed steam and electric railroads nor railways under construction during the census year which had not begun operations.

The figures presented for California show general gains in the industry during the decade 1902-1912. The number of electric railway companies in the state increased from 35 to 1902 to 44 in 1912, a gain of 26%. The gross income amounted to $34,845,771 in 1912, as compared with $9,967,838 in 1902, an increase of 250%. The revenue passengers carried numbered 520,741,159 in 1912 as compared with 182,196,999 in 1902, an increase of 186%. The miles of track increased from 829 in 1902 to 2606 in 1912, a gain of 214%. The number of persons employed was 16,749 in 1912 as compared with 5442 in 1902, an increase of 208%. The total horse-power increased from 38,085 in 1902 to 48,311 in 1912, or 27%, but the bulk of the power consumed by the electric railways was purchased as current, 481,625,400 kw-hr. of purchased current being reported in 1912. Figures for quantity of current purchased by the electric railways in prior census years were not available. The quantity of current generated by the railway companies shows a decrease, the figures in 1912 being 11,274,069 as compared with 44,676,030 in 1902, or a 75% loss. The figures in detail are shown in the accompanying table as follows:

	1912.	1907.	1902.	Increase[1] 1902 to 1912, %.
Number of companies	44	42	35	25.7
Operating	35	41	35	.....
Lessor	9	1	.....	.....
Miles of line	1,766.20	1,264.10	551.40	220.3
Miles of single track	2,606.40	2,013.49	829.10	214.4
Cars, number	4,652	3,760	2,056	126.3
Passenger	2,791	2,406	1,850	50.9
All other	1,861	1,354	206	803.4
Electric locomotives	49	15	.....	.....
Persons employed	16,749	11,466	5,442	207.8
Salaried employees	1,748	904	255	585.5
Wage-earners (average number)	[2]15,001	10,562	5,187	189.2
Power:				
Horse-power, total	48,311	60,655	38,085	26.8
Steam and gas-engines, including turbines:				
Number	46	52	74	–37.8

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	1912.	1907.	1902.	Increase[1] 1902 to 1912, %.
Horse-power	48,046	60,455	31,590	52.1
Water wheels:				
Number	3	2	8	-62.5
Horse-power	265	200	6,495	-59.2
Kilowatt capacity of dynamos	30,817	44,400	22,897	34.6
Output of stations, kilowatt-hours	11,274,069	111,870,849	44,676,030	-74.8
Current purchased, kilowatt-hours	481,625,400	([3])	([3])	.....
Passengers carried	683,326,934	441,895,205	241,325,720	183.2
Revenue	520,741,159	327,977,151	182,196,999	185.8
Transfer	150,298,412	109,230,255	59,128,721	154.2
Free	12,287,363	4,687,799	([3])	.....
Car mileage (passenger, express, freight)	116,553,876	74,785,472	41,512,788	180.8
Condensed income account of operating companies:				
Gross income[4]	$34,845,771	$21,545,797	$9,967,838	249.6
Operating expenses	$21,684,312	$14,578,367	$5,402,245	301.4
Gross income less operating expenses	$13,161,459	$6,967,430	$4,565,593	188.3
Deductions from income (taxes, fixed charges, and miscellaneous)	$10,696,969	$6,732,705	$2,112,959	406.3
Net income	$2,464,490	$234,725	$2,452,634	0.5

[1]A minus sign (-) denotes decrease.

[2]Number employed September 16, 1912.

[3]Figures not available.

[4]Income from sale of electric current included in 1912, $75,817; 1907, $366,566; and 1902, $279,216.

International Engineering Congress, 1915

THE attention of the engineers of the world is being more and more drawn to the program of the International Engineering Congress which is to be held in San Francisco, California, in 1915. The interest which has been aroused in foreign countries is shown by the fact that at the present time there have been received enrollments and subscriptions from 42 such countries. It is furthermore to be noted that of the present total enrollment, approximately 25 per cent is from countries other than the United States. The number of subscriptions from the members of the five national engineering societies of the United States under whose auspices and control the Congress is being held is, however, not so gratifying. The percentage of the total membership of these five societies represented by the subscription list is only 3.7, and this, although each individual member of these societies has received circular information and data concerning the Congress and has been urged to send in his subscription promptly.

It is probable that this is largely due to the fact that the date of the Congress is still somewhat in the future, and also to the tendency of the individual to procrastinate. This, to a considerable degree, handicaps the work of the Committee on Management, and it is extremely desirable that as many as possible who intend to subscribe should do so at an early date.

The list of topics to be treated in the Section on Mechanical Engineering gives a very good idea of the character of the publications which it is intended to issue and the topics which will be presented and discussed at the meeting. These are as follows:

(1) Recent progress and present status of foundry practice, and casting metals.
(2) Recent progress and present status of the art of forging.
(3) Equipment processes, and methods for the boiler-shop.

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(4) Machine-shop equipment, methods, and processes.
(5) Automatics.
(6) Special processes for shaping and forming metals.
(7) High temperature flames in metal-working.
(8) Industrial management.
(9) Safety engineering.
(10) Industrial Museums as an educational factor.
(11) The steam-engine of the year 1915.
(12) The steam-turbine of the year 1915.
(13) The internal-combustion engine of the year 1915.
(14) Motors of the Diesel type.
(15) The Humphreys gas pump.
(16) The steam boiler of the year 1915.
(17) Refrigeration.
(18) Pneumatics.
(19) Lubrication and lubricants.
(20) Water wheels of pressure type.
(21) Water wheels of impulse type.
(22) Hydraulic power developments and use.
(23) Power-plant design.
(24) Motor vehicles, passenger type.
(25) Motor vehicles, utility type.
(26) Motor tractors.

Many of these topics will be treated as symposiums with contributions representing the practice in more than one country.

The various sections outlined for the work of the Congress and the volumes to be issued are as follows:

Vol. I. The Panama Canal.
Vol. II. Waterways and Irrigation.
Vol. III. Municipal Engineering.
Vol. IV. Railways and Railway Engineering.
Vol. V. Materials of Engineering Construction.
Vol. VI. Mechanical Engineering.
Vol. VII. Electrical and Mechanical Engineering.
Vol. VIII. Mining Engineering and Metallurgy.
Vol. IX. Naval Architecture and Marine Engineering.
Vol. X. Military Engineering, and Miscellaneous.

It will be noted that the proceedings of the Section on Mechanical Engineering will be published in Vol. VI, with some of the papers falling into Vol. VII. It is also noted that Vol. X will consist only in part of Military Engineering and will also contain papers on miscellaneous topics which are not definitely associated with any of the various sections.

Full information concerning the Congress may be obtained by addressing the Committee of Management as follows:

International Engineering Congress, 1915,
Foxcroft Building,
San Francisco, California,
U. S. A.

Petrographic Range of Road-Building Materials*

By CHARLES P. BERKEY

It frequently falls to the lot of a petrographer to classify stone which it is proposed to furnish for a special piece of work, and to give an opinion as to its fitness or its likelihood of meeting the requirements of specifications. In most cases these requirements are very far from being specific, in a petrographic sense—that is, precise rock names are rarely used, whereas some general term or some phrase descriptive of the quality is common. The commonest term of all is 'trap.'

A few quotations copied from standard specifications covering regular contracts under various state and municipal departments, and bureaus of highways, are given below as representative of this usage:

(a) "Only broken stone * * of a hard and compact texture and of uniform grain will be allowed. * * Disintegrated and rotten stone * * will not be accepted."

(b) "The trap rock shall be of satisfactory quality, equal to that used in * * * for macadam roads."

(c) "The mineral aggregate used shall consist of trap rock, newly broken, of uniform quality throughout, free from slaty and flat pieces, soft or disintegrated stone, dirt and other objectionable material."

(d) "The stone * * must be trap or ap-

*Abstract from Columbia *School of Mines Quarterly*, November 1913.

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proved native rock. It must show a fresh crystalline surface."

(e) "All stone must be * * the same kind and quality, equally good in every particular as that shown in the engineer's office."

(f) "Only good, solid stone shall be used * * Bidders will name the kind of stone they propose using in said work, also its location."

(g) "* * shall consist of first quality trap rock * * Mineral aggregate shall be clean crushed trap rock of approved quality."

(h) "Crushed stone shall have a coefficient of wear, according to the Duval test, of not less than 8, and a cementation value of not less than 50."

(i) "The first course shall consist of sound rock * * Unless otherwise specified, the stone of the second course shall be trap rock. * * For the third course other material than trap rock screenings may be used if approved by the engineer."

(j) "Stone for macadam shall consist of approved local stone, trap rock, or a combination of local stone and trap rock * *"

(k) "The crushed stone shall be trap or other suitable rock, satisfactory to the office in charge."

(l) "The macadam shall be of limestone of approved quality. * * The stone must be of good and uniform texture."

(m) "All stone for concrete shall be hard limestone, sandstone, trap, furnace slag, quartzite, or granite, acceptable to the chief engineer. Broken stone must be quarried from massive ledge, and any stone which shows a tendency to break into flat, thin pieces will be rejected."

(n) "The broken stone shall be trap, granite, or limestone, or such other stone taken from the line of work as shall be satisfactory in the judgment of the engineer."

Such a summary is probably fairly typical. From it two or three generalizations may be made. For example: (1) The standard, so far as there is a standard, with which all rocks are compared in highway work, is 'trap.' (2) Trap is usually specified by name wherever there is any reasonable hope of furnishing it for the contract. (3) Wherever substitutes are encouraged, they are either indicated by name or are described in efficiency terms, or the responsibility is placed on the engineer in charge.

It is the general opinion, based on experience, that the 'traps' are pre-eminently satisfactory for highway uses. But trap is not a very definite petrographic term. In a very broad way, this means that the basic igneous rocks of massive structure, and having a tendency to diabasic or closely interlocked habit of the mineral constituents, are the best road material. The acid igneous rocks are not so successful, especially when there is heavy traffic sufficient to test the toughness of the rock. The metamorphic rocks, as a class, are not regarded with much favor. The clastic or fragmental rocks, as a rule, are not recommended, but limestones are very serviceable where hardness is not a prime essential. In every large class of rocks there are special types which prove to be of acceptable grade, but no large class compares with the basic igneous rocks for general efficiency under the most exacting conditions.

In spite of this apparent reduction to such simple terms in the matter of range of rock types regarded as acceptable, as a matter of fact a great variety of rocks are actually used and are quite worthy of serious consideration. Many factors enter into the question of choice; it is not always a simple problem. There is little excuse for a state like Ohio to demand trap in any except the most critical cases, for there is not a single trap ledge in the state or anywhere near its borders. It may well happen, in many cases, that the increased efficiency is more than counterbalanced by the extra cost over local stone. In the average case, local stones everywhere merit serious consideration, and a little judicious discrimination will usually discover an acceptable one.

It is in this connection that critical knowledge of rock variation will be found useful. Names of rocks alone are not so useful as might at first appear, because all types vary greatly in minor points of texture, structure, chemical, and dynamic modification, and consequent efficiency. No amount of mere classification can take the place of careful discrimination of structural variety within the principal types themselves.

It may be useful, however, to consider briefly the range of types coming within observation for such uses, and to indicate their petrographic grouping. Probably no publication on rock for highway uses has

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given a fuller list of varieties than *Bulletin* 44 of the Office of Public Roads, U. S. Department of Agriculture, Washington.

The following list has been compiled from this and other sources, and the terms are classified under the commonly used headings familiar to all students of natural rock materials. In it there is no attempt to indicate relative value for actual use. For reasons suggested in an earlier paragraph it is certain that particular varieties of a type which is usually considered of poor quality may very well prove to be much superior to the more faulty varieties of rock types that are generally regarded as high-grade. The descriptive terms following some of the rock names indicate the varieties that have been used; the terms are inserted just as they occur in the literature, without any attempt to reduce them to uniformity.

I. Igneous Rocks:

(*a*) Volcanic fragmental materials:

1. Volcanic ash.
2. Volcanic breccias.
3. Rhyolite tuff.
4. Andesite tuff.
5. Basalt tuff.

(*b*) Surface flows (crystalline lavas, felsitic, and slightly porphyritic in texture and showing flowage structure):

6. Rhyolite and rhyolite breccia.
7. Felsite and brecciated felsite.
8. Trachyte.
9. Andesites: Augite; Hornblende; Andesite breccia.
10. Basalt: Vitreous; Olivine; Chloritized.

(*c*) Intrusive masses (dikes, sills, etc.; strongly porphyritic or intimately interlocked in texture):

11. Granite prophyry.
12. Syenite porphyry.
13. Camptonite.
14. Diabase (trap of highest grade): Hypersthene; Uralitic; Olivine; Augite; Gabbro; Meta-diabase.
15. Diabase porphyry.
16. Peridotite.
17. Pegmatite.

(*d*) Plutonic masses (deep-seated in origin; granitoid in texture and massive structure):

18. Granite: Hornblende; Porphyritic; Muscovite; Microgranite; Gneissoid.
19. Syenite: Augite; Quartz.
20. Granodiorite.
21. Diorite: Quartz; Augite; Basic; Porphyritic.
22. Gabbro: Hornblende; Hypersthene; Uralitic.

In the above grouping, the field relations are indicated in the sub-headings, and under each the rock types of which the names have been found mentioned in road tests, or rock lists for such purpose, have been arranged approximately in order from the more acid to the more basic in composition.

II. Sedimentary (clastic) rocks and associated organic accumulations and aqueous precipitates, together with special modifications:

(*e*) Simple sediments (arranged from fine to coarse grain)

23. Shale: Clay; Ferruginous; Carbonaceous; Calcareous.
24. Sandstone: Argillaceous; Calcareous; Ferruginous; Chloritic; Feldspathic; Arkose; Kaolinized; Biotite; Indurated; Metamorphosed; Conglomeritic.
25. Conglomerate.

(*f*) Organic in origin, with or without sedimentary intermixture, and usually with some modification:

26. Limestone: Shell; Fossiliferous; Clay; Argillaceous; Bituminous; Siliceous; Nodular; Oolitic; Cherty; Dolomitic.
27. Dolomite: Argillaceous; Arenaceous; Siliceous.

(*g*) Precipitates:

28. Travertine (tufaceous limestone).
29. Gypsum.

(*h*) Special segregations, etc.:

30. Quartz.
31. Chert: Calcareous; Dolomitic.
32. Flint.
33. Hematite.
34. Phosphate rock.

III. Dynamic fragmental materials:

(*i*) 35. Breccia: Quartz; Quartzite; Brecciated felsite.

IV. Metamorphic rocks (that have been recrystallized and have lost most of their original structural habit and in part their mineralogic habit. As a rule they have a foliate structure and break much more readily in one direction than in others):

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(*j*) Fine-grained types (with good rock cleavage):

36. Slate or argillite: Clay; Siliceous; Calcareous; Indurated slate.

(*k*) Medium grained (rather massive and comparatively little foliate habit):

37. Quartzite: Calcareous; Sericitic; Feldspathic; Chloritic; Pyroxene; Epidote; Hornblende; Micaceous.
38. Graywacke.

(*l*) Strongly foliated and usually of medium grain (commonly of abnormal composition, that is, some mineral other than feldspar in excess):

39. Schist: Quartzite; Mica; Biotite; Quartz-mica; Hornblende; Mica-hornblende; Hornblende-mica; Chlorite; Hornblende - chlorite; Garnet-hornblende; Quartz-hornblende; Tremolite; Talc schist (soap-stone).

(*m*) Foliated structure, medium to coarse grain, sometimes banded and of normal composition (that is, the usual feldspathic mineral makeup):

40. Gneiss of unstated relations: Quartz; Sericite; Horn-blende; Arkose; Chlorite; Muscovite; Biotite; Pyroxene.
41. Granite gneiss.
42. Syenite gneiss.
43. Diorite gneiss.
44. Gabbro gneiss.

(*n*) Massive types:

45. Marble: Dolomite marble.
46. Serpentine: Hornblende serpentine.
47. Amphibolite.
48. Eclogite: Mica eclogite.
49. Epidosite.

This list represents in reality a very wide range. It is certain that many of them are of very low efficiency, but in spite of that they have been found worthy of consideration and test. No. 10, 13, 14, 15, and 21 are the prominent 'trap' representatives. Diabase, No. 14, is the type usually meant when the term is used in specifications. But it is not a closely defined petrographic term and is often more loosely used.

The fact that these rock names appear as having been considered worthy of attention for road-building purposes, does not necessarily indicate special fitness of all these types. Many of them are doubtless poor grade compared with trap, but they may in spite of that be superior to the only other material warranting practical comparison in a given case. Furthermore, the fact that any one of these has been used successfully cannot be taken as evidence that every occurrence of the rock of the same petrographic classification would be acceptable, since so much depends on the physical condition, freedom from decay, texture and special structural factors of each occurrence. I say nothing of other factors of control lying outside of my present line of discussion—such as availability of other competing materials, transportation difficulties, allowable cost, uses to which the road is to be put, etc.

No doubt it would be a great convenience for highway engineers if a special classification, in which the prominent efficiency factors were given chief place, could be devised. The chief difficulties with such a scheme are:

(1) That it is an attempt to simplify data that are essentially not simple.

(2) That its basis could not coincide at all with that of any other rock classification; and therefore,

(3) That the terms used in classification could not agree closely with those in common use.

The result would be, it seems to me, that we should have another classification to become familiar with, instead of accomplishing a simplification. On the whole, there is as yet no better suggestion than that the commonly used terms for description and naming should be thoroughly mastered and that the nature of the structural and textural basis of difference in quality should be full understood, and that the geological and petrographic principles underlying the history of rocks should be a part of one's professional equipment.

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Street Railways and Electric Lighting in China*

By D. C. ALEXANDER, Jr.

THE cars of the Shanghai Electric Construction Co. are operated by power from the Shanghai Municipal Council's electric plant. Direct current for the street railway is generated in the Fearon road station by two duplicate sets of Bellis & Morcom triple-expansion vertical engines, each direct connected to a 600-kw. dynamo from Bruce, Peebles & Co. These engines run at 230 r.p.m., and current is generated at 550 volts and up to 1200 amperes. The condensers for these two sets are of the surface type, with motor-driven air and circulating pumps, supplied by Richardson & Westcott, of England. A 1000 ampere-hour storage battery from the Chloride Co. is also maintained in conjunction with the traction-current supply.

Until very recently the Fearon Road station has also supplied all of the council's current for lighting and power. The original installation for these purposes consisted of several small single-phase dynamos and compound vertical engines which were superseded by one Parsons and one Willans high-pressure steam turbines, running at 1500 r.p.m. and each driving a Bruce, Peebles & Co. dynamo of 1000 kw. maximum capacity. Originally single-phase current at 2100 volts and 50 cycles was generated; but later these turbine dynamos were rewound for 2-phase current at 2000 volts and 50 cycles. When additional power became necessary, two Howden mixed-pressure turbines were added, with 2-phase Siemens Bros.' dynamos, each rated at 480 kw., but now actually producing 700 kw. each at 2000 volts. The 2-phase current is converted for transmission to 3-phase at 6000 volts, by groups of step-up transformers on the Scott system. The direct-current (traction) switchboard is from Ferranti & Co., of Hollingswood, England; and the other electrical switch gear from the British Westinghouse Co., and Brown, Boveri & Co., of Badeo, Switzerland.

The steam plant of the Fearon Road station consists of six Babcock & Wilcox marine-land type boilers, with chain-grate stokers, having a combined capacity of 5200 horse-power. Each boiler has on top an independent feed-water heater in the main flue, and the two 1000-hp. boilers have self-contained superheaters, while a separately fired superheater handles the steam from the other four. Draft is maintained by a rotary blower from Matthew Paul & Co., of Dumbarton, Scotland, driven by a compound vertical engine from W. H. Allen & Son, of Bedford.

With the exception of two 450-hp. jet condensers from the Wheeler company of New York, all the condensers are of the surface type, and have in most cases been supplied with their pumps by the makers of the engines to which they are attached. A 12½ by 9¾ by 26-in. single vertical marine-type pump from Clarke, Chapman & Co., of Gateshead on Tyne, constitutes the main boiler feed, while W. H. Allen & Son have supplied a number of auxiliary pumps.

In the sub-stations of the Fearon Road station the current is transformed from 3-phase at 6000 volts to single phase at 400 volts, and distributed on the 3-wire system, giving 400 volts across the two outers and 200 across one outer and the neutral wire, which is grounded. Three-phase current from the new Riverside station will be distributed from the sub-stations on the 4-wire system, one wire for each phase, and a neutral wire earthed. This arrangement will give 350 volts between any two phases, or 200 volts between one phase and the neutral. Thus lighting consumers on single phase are given 200 volts, while small power consumers may have 3-phase at 350 volts.

The flat rate for lighting is 0.10 tael (6.7c. U. S. currency) and for heating and cooking 0.025 tael (1.67c.). Small consumers (up to 50 hp.) are charged 0.025 to 0.035 tael (1.67 to 2.34c.) for power; large consumers have special rates. Those taking steady continuous loads, like cotton and flour mills, have a rate which is less than 1c. per kilowatt-hour.

The Riverside station is a new plant built by the municipal council and put into service only in April 1913. Its design and

*Abstract from U. S. Consular and Trade Reports, January 9, 1914.

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equipment represent the latest engineering practice, and it is likely to become the most important steam-electric power station in the Far East.

The following table gives service statistics of the Fearon Road station:

	1904.	1911.	1912.
Connections to mains	900	4,620	6,870
Lighting (not including public lights) equivalent to 30-watt lamps	66,840	267,476	337,160
Total horsepower in motors	60	1,780	3,030
Total units sold and accounted for (light, heat and power)	1,200,000	8,280,000	12,130,537
Pounds of coal consumed per unit sold	16	5.52	5.04
Load factor	16.2	23.65	23.52
Maximum load in kilowatts	850	4,000	†6,000

†Estimated for December 1914 at 11,300 kilowatts.

The prime motors in the new plant are two turbo-alternator sets from the Allgemeine Elektricitäts Gesellschaft, of Berlin. The turbines are of the high-pressure impulse-reaction type, with a guaranteed steam consumption of only 14.5 lb. per kilowatt-hour. The dynamos, which are designed for 3-phase current of 50 cycles, are rated at 2000 kw. each, but are capable of carrying 25% continuous overload. Current is transmitted at 6000 volts by underground cables to 70 transformer stations in various parts of the city, where it is transformed to low voltage in oil transformers built by the General Electric Co., of New York. Two large surface condensers were also furnished by the Allgemeine Elektricitäts Gesellschaft; but the air and circulating pumps are from W. H. Allen & Son. These, and all the auxiliary pumps (except a single steam boiler-feed pump), are driven by 3-phase induction motors of squirrel-cage pattern taking current from a 6000/500-volt transformer. A storage battery from the Chloride Co. has also been installed, with a British Westinghouse motor-generator set for charging.

The main and auxiliary switch gear, which is from the British Westinghouse Co., is placed in a gallery over the engine-room floor, and is so designed that a single man at the operating bench can control not only the entire electrical plant, but also the speed of the turbines, which are electrically controlled. The condensers, boilers, and their auxiliaries are placed on the floor below the turbo-alternators; and beneath this is a basement, with rail line and trucks for removing the ashes, which slide down an incline from the ash-pits. At present four Babcock & Wilcox water-tube boilers are installed, each to evaporate 22,000 lb. of water an hour into steam at a pressure of 180 lb. per square inch. Each boiler has a self-contained superheater, designed for 150°F. of superheat, and there is a Green's economizer in each main flue. These flues connect with two 70-ft. steel stacks, in which forced draft is maintained by fan blowers.

Coal is taken from steamers or barges by a traveling jib crane and passed through an automatic weighing hopper to a bucket conveyor, which delivers it to a series of steel hoppers over the boilers. From these it passes by gravity to the feed hoppers of the mechanical stokers. All of the coal-handling apparatus is motor-driven, and the reserve bunkers (of 1000 tons capacity) are so placed as to discharge by gravity into the bucket conveyor. The buildings of the power plant are of steel, concrete, brick, and corrugated iron construction, and provision has been made for large extensions. A 25-ton electric traveling crane is installed for handling the machines in the engine-room.

The cost of the land, buildings (including employees' quarters), and equipment will amount to about $470,000, U. S. currency, the machinery alone representing $125,000. As the entire output of this station was contracted for by some of the Shanghai cotton mills before the plant was completed, it has been practically decided to add two more turbo-alternators of 5000 kw. each to the Riverside plant, together with four additional boilers, etc. In the meantime the council is spending large amounts for high-tension underground cables, new sub-stations, and various equipment. The Fearon Road station is likely soon to become merely an auxiliary plant and switch and distributing centre, and may in time be entirely shut down. In this event, direct current for the street railways would be produced by motor generators.

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The Tientsin tramways, with the auxiliary lighting plant, are the outcome of an agreement, made in 1904, between a Belgian syndicate (represented by E. Meyer & Co., of Tientsin) and the then viceroy of Chili province, H. E. Yuan Shih Kai. By the terms of this agreement the syndicate was authorized to construct a metre-gauge electric street railway in and about the native city of Tientsin and to install a lighting system within the native city.

In addition to the line around the native city and in other Chinese territory, the company's lines extend through the Japanese, Russian, Italian, Austrian, and French concessions, with the Settlement railway station and bund as termini. These lines were built under agreements made between the Company and the authorities of the various concessions through which they pass, but for some reason the service has not been extended to the British and German concessions. In connection with the double-track line which runs about the native city, it is interesting to note that it is laid upon a boulevard which was built at the close of the Boxer outbreak upon the site of the old city wall, which was razed at that time.

The agreement between the viceroy and the Belgian company specifies the manner in which the track must be laid and maximum rates for lighting and street railway fares, and provides for an initial payment by the Company of 50,000 taels, and subsequent annual payments in lieu of taxes, based upon the Company's gross and net earnings. Provision is also made for the optional repurchase of the entire plant by the Chinese authorities at the end of any seven-year term, or, failing repurchase, for the transfer, "as a present to the viceroy of the province," of the entire plant and equipment at the expiration of 50 years. Furthermore, it is agreed that matters in dispute between the Company and the Chinese authorities, or between the Company and Chinese subjects, shall be settled by an arbitration board, "without reference to any foreign consular or other foreign court."

Construction work was begun in 1904, and regular service of street-cars and lighting commenced in 1906. At present the Company has a total of 7¾ miles of double track, laid with rails of grooved girder pattern weighing 92 lb. per yard. The rails, which are 19.7 yd. in length, are laid upon broken limestone beds, with tie-rods spaced 5 ft., and are double bonded. The wires are carried upon 19-ft. tubular iron poles, which on wide streets are set between the two tracks and on narrow streets on one side. The roadway between the rails and for 19 in. on each side is stone flagged, and maintained at the Company's expense.

The street railway service is now maintained by 66 cars equipped with double motor sets, and 50 trailers. All of the motor cars and some of the trailers were imported complete from Belgium and Germany; but the wooden bodies of newer trailers have been built in the Company's shops, upon designs which have been found more suitable to local conditions. For the sake of cleanliness, the cloth window curtains and seat upholstery have been entirely eliminated and wooden seats substituted. Moreover, as the costume of both Chinese men and women makes a high step very difficult, the floor of the new trailers is only as high as the axles, with a single step at the entrance. The new trailers have no platforms or doors at the ends of the car, entrance and exit being by double side doors which are kept locked while the car is in motion. Each car seats 60 persons, and each platform of the motor cars carries 8 to 10 more, a small railed-off inclosure being reserved for the motorman. With minor exceptions, the entire route is double-tracked, and the service fairly frequent. On three lines cars run at three-minute intervals, while on the fourth the interval is six minutes.

On an average of 2,000,000 passengers are carried per month. In former years an attempt was made to reserve a small section of each car for first-class passengers at an extra fare, but this has been abandoned, owing to lack of patronage, and only one class is now maintained. On the line around the native city the fare for a journey from the east to the west gate (one-half of the circumference of the city, or about 1½ miles) is 2 Mexican cents (4/5 cent U. S. currency); while on the longer line, which passes through the foreign concessions, the fare is 3 Mexican cents for a maximum distance of 3½ miles. Fares are usually paid in copper cents, the takings of these being about 200,000 per day. However, as copper coins are considerably depreciated in relation to the silver currency, the Company posts in its cars rates of exchange between

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the two; and a passenger who, for example, tenders a silver Mexican or Peiyang dollar in payment of his fare is entitled to receive, say, 16 silver 10-cent pieces and some odd coppers in change, depending upon the exchange rate for the day. The Company estimates its loss on copper coin at 30%, and as Chinese silver also fluctuates in value in relation to European currency, a further loss may be suffered. For instance, the Company must exchange 130 to 135 copper cents for 1 Mexican dollar, and then the value of the Mexican dollar may sink from, say, 2s. 2d. to 2s., or even lower.

Direct current at 550/600 volts is employed for the street railway service, all car motors being of 25 hp. The older motors and controllers are from Siemens & Schuckert, of Berlin; but the more recently imported motors and controllers have been purchased from the Ateliers de Constructions Electriques de Charleroi, Belgium. For the locally built trailers, wheels and axles only are imported.

For the lighting circuit, which includes not only the native city but also the Italian, Austrian, and Russian concessions, the three-wire system at 250 volts direct current is employed. On January 1, 1913, the equivalent of about 20,000 30-watt lamps were installed and the number is increasing very rapidly. For the direct-current system is about to be substituted the 3-phase system, 5000 volts high tension and 220 volts low tension.

The present power and lighting plant consists of four horizontal tandem compound engines with Lenz valve gear, each coupled direct to a 325-kw. direct-current dynamo of 550/600 volts, and 0/542 amperes. The engines and surface condensers, with their pumps (the latter driven from the main shaft of the engine), are from Van den Kerchove, of Gand, Belgium; while the dynamos, switchboard, and other electrical equipment are from the Allgemeine Elektricitäts Gesellschaft, of Berlin. Two of the four units are operated simultaneously on the street railway circuit, and the other two are reserved for lighting. On February 20, 1913, the peak load for the street railway circuit was 1190 amperes; and for the lighting, 950 amperes; the total power output for the day being 10,800 kilowatt-hours.

A new Green's economizer is now being erected, and two 1500-kw. turbo-alternators will soon be installed. However, the four boilers now in use are said to have a capacity double the present engine requirements, so no additions to the boiler-house are anticipated. These boilers are of the Elephant type, rather unusual in America, consisting of a lower shell which contains three corrugated fire-boxes and several gas passages, and a superimposed shell with a number of 2-in. fire tubes. The combustion gases pass from the fire-boxes in the lower shell through the tubes in the upper shell, and then again through the passages in the lower, escaping by a flue under the boiler. Their fuel economy appears to be good, but they require frequent cleaning. The boilers in the Tientsin station are from Les Grandes Chaudronneries de l'Escaut-Hoboken, Belgium, and the feed pumps are from Weise & Monski, of Halle, Germany. Kaiping coal, at about $2.50 to $2.60 U. S. currency per ton, delivered in Tientsin, is used as fuel; stoking is done by hand.

The street-railway repair shops are at Nankai, just outside the native city, and adjoin the car barns. The buildings are of steel, brick, and concrete, the car barn having 12 lines of rails with pits underneath. The shops consist of five bays, each 30 ft. in width, of which three have rail lines laid through and are reserved for car building and repair. The machines of all kinds occupy the other two bays. At present woodworking and metalworking machines are intermixed; an addition to the shops is planned for the painting of cars. Practically all the machines of both classes are of Belgian manufacture. Edouard Mennig, of Brussels, has supplied all the woodworking machines, consisting of a four-spindle molder, a band saw, a circular-saw bench, and an automatic band-saw filing machine. There are no log-sawing machines of any kind, this work being undertaken by Chinese sawyers, using whipsaws, at a rate of 1½ Mexican cents per running foot in 12-in. beams. Moreover, hand tools of Chinese manufacture are much more largely employed than machines in planing, sanding, mortising, tennoning, shaping, and carving.

Most of the metal-working machines are from the Constructions Mecaniques de Longdoz, of Liege, Belgium. These include a 36-in. engine lathe, a 12-in. capstan lathe with thread-chasing attachment, a couple of upright drills, a small crank shaper, and

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a 44-in. wheel lathe. Owing to the lack of experience of native hands, it is said to require 12 hours to turn up a single pair of tires. The only new machine tools are a No. 1 universal miller and a universal tool and cutter grinder, both from the Ateliers Demoor, of Brussels. This milling machine is employed principally upon steel motor pinions, which are first roughed out on the shaper. The works manager stated that when indenting for these new tools, he specified certain American makers, but that the Belgian machines which the Brussels office chose instead have been fairly satisfactory. They are American design in almost every particular. A single 26-hp. motor drives all the wood and metal working machines.

The plate and smith shops are combined and contain only four double fires and a double punch and shear of Belgian make. There are no steam or power hammers. The foundry also is very small, with only a couple of portable Chinese-pattern cupolas, and a one-crucible brass furnace. Adjoining the machine-shop is a small electrical shop in which motors are rewound and other electrical apparatus repaired.

At present, while the shops are engaged in building new trailers, 280 workmen are employed, but the usual number is from 100 to 150. The Company provides small Chinese-style houses for the workmen, rent free; and a free bathhouse is maintained, daily baths for motormen and conductors being compulsory. Wages are paid as follows, per month: carpenters, $6.70 to $7.70, U. S. currency; fitters, $6.70 to $9.25; machine hands, $6.15 to $7.70; smiths and plate workers, $6.70 to $8.25; electricians, $7.70 to $10.25. These wages are, of course, only for Chinese workmen, the European foreman and instructors being very liberally paid.

The paid-up capital of the Company is now 6,250,000 francs ($1,206,250), and the first dividend of 4% per year was paid to stockholders in 1912, after five years of operation without any return to the shareholders. The dividend for 1913 is expected to be 6%, and a steady progress is anticipated for the future.

In conclusion, the writer desires to acknowledge his indebtedness for most of the facts and figures contained in this report to M. Georges Gaillard, chief engineer of the Tientsin Tramways & Lighting Co.; D. McColl, M. Coursier, and J. Lo Pa Hong, managers, respectively, of the British, French, and Chinese street railways in Shanghai; and to T. H. U. Aldridge, chief electrical engineer for the Shanghai Municipal Council, whose efforts toward improving and extending electrical service in Shanghai cannot fail to have far-reaching results throughout China.

Bureau of Mines Experiment Station

PLANS for the proposed $500,000 experiment station of the U. S. Bureau of Mines to be located in Pittsburgh, Pennsylvania, have been approved by the commission appointed by Congress for that purpose. The federal government now owns the property upon which will be erected a group of buildings, especially designed and adapted for the carrying on of the mine safety work and other investigations in which the Bureau of Mines is interested.

Congress a year ago, in the Public Buildings bill, authorized a new home for the Bureau of Mines to cost $500,000. It is now expected that Congress, in its present session, will make a specific appropriation so that construction work may begin. It is hoped that contracts may be let by July 1. The Director is hopeful that the buildings may be completed in the fall of 1915, when they will be dedicated with suitable ceremony, including a second National Mine Safety Demonstration, similar to that held at Pittsburgh in 1911.

The commission which has approved the plans consists of J. A. Holmes, D. C. Kingman, Chief of Engineers of the United States army, and O. Wenderoth, Supervising Architect of the Treasury. The state of Pennsylvania has appropriated $25,000 for coöperation in establishing this experiment station and has appointed a state commission consisting of James E. Roderick, Chief Mine Inspector, Dean W. R. Crane, of the Mining Department, Pennsylvania State College, and W. H. Caverly.

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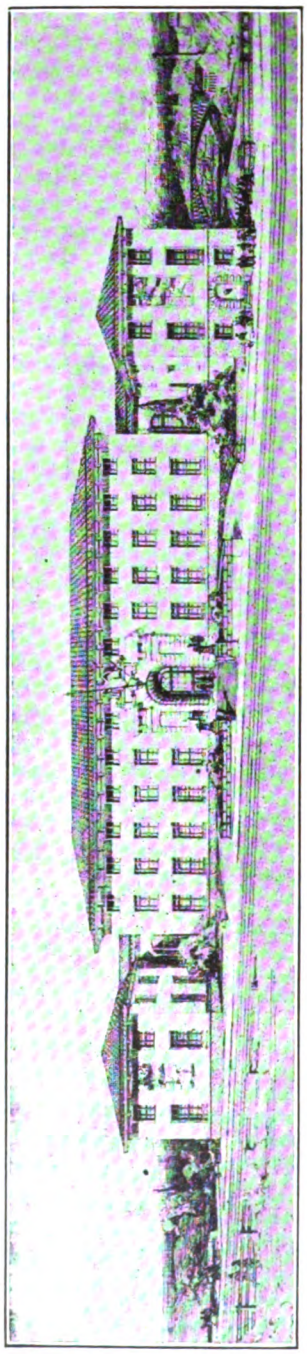

BUREAU OF MINES EXPERIMENT STATION, PITTSBURGH, PENNSYLVANIA.

The buildings which will constitute the experiment station of the bureau will form a part of a most remarkable and unusual group of monumental edifices devoted to educational purposes. On one side the Bureau's buildings will face the great group of structures of the Carnegie School of Technology. On another side is the Carnegie Institute, in which are the art gallery, museum and library. Nearby is the imposing pile of buildings of the University of Pittsburgh. Other nearby buildings are the Memorial Hall, Pittsburgh Athletic and University Clubs, and the Hotel Schenley. The site consists of nearly 12 acres of land, part of it on the higher level of the city streets and part of it on the level of the B. & O. railroad, which railroad will furnish adequate facilities for passengers and freight traffic.

The group consists of three main buildings facing Forbes street and the several street-car lines from the uptown district. The central building of the group, the Mining building, will be three stories in height, flanked by two main buildings, one the Mechanical and the other the Chemical building. In the rear of these and inclosing a court will be the Service building. Beyond the Service building, and spanning what is known as Panther Hollow and thus connecting the Bureau of Mines buildings with the Carnegie schools, will be two buildings over the roofs of which will pass the roadway from Forbes street to the Carnegie School buildings and Schenley park.

Between the main group and the power and fuel group will be the entrance to a series of mine shafts. One of these will be used as an elevator to carry heavy material and passengers from the lower level to the upper; another will be for tests of hoisting ropes and similar mining appliances; another will be an entrance to tunnels extending under the buildings and in which mining experiments, such as fighting mine fires, will be conducted.

The portion of Panther Hollow above the Power buildings will be arranged as a Miners' Field, the slopes of the ravine being utilized as an amphitheatre which will accommodate 20,000 spectators who may assemble here to witness demonstrations and tests in mine rescue and first-aid.

The main or Mining building will contain the administrative offices, and those of the mining force. In it will be an assembly and lecture hall, a library and smoke and other rooms for demonstrations and training in mine rescue and first-aid. The Mechanical building will be for experiments and tests of mining machinery and appliances and the Chemical building for inves-

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tigation and analyses of fuels, explosives, and various mineral substances.

The buildings now used by the Bureau of Mines as an experiment station at Pittsburgh were loaned to the Bureau by the War Department as an emergency measure when the Bureau was created. The War Department has suggested that it now needs these buildings, and it is felt the Bureau cannot retain possession much longer. The buildings are very old and are entirely unsuited to the needs of the Bureau of Mines work. It is said that the investigations have been seriously handicapped by the inadequacy of the structures now in use, which are totally unsuited for the purpose.

Industrial Gas Calorimetry

FOR many years all laws and regulations relating to manufactured gas were based on candle-power requirements; that is, the gas burned in a definite burner at the rate of 5 cu. ft. per hour was required to give a specified illumination of so many candle-power. This specification furnished a perfectly satisfactory control of the quality of gas delivered so long as the gas was chiefly used for illuminating purposes with the old style of open-flame gas burner. At the present time, however, this inefficient type of burner has been very largely displaced by burners of the Welsbach mantle type. Furthermore, a large amount of the gas sold today is used for cooking purposes and to some extent for operating small gas-engines for power purposes. In these applications of gas it is the heating value that is of first importance and not the candle-power. It has been estimated that less than 20% of the gas manufactured and sold today—indeed, in many of our cities and towns less than 10%—is used in the old type of open-flame gas burners. Notwithstanding this fact, we still find in most of our cities and towns ordinances on the statute books requiring that the gas meet a definite candle-power test, while no attention has been given to the question of heating value, which is the important factor for over 80% of the gas sold. Many of the candle-power requirements fixed by law are quite high, often requiring the manufacture of an expensive oil-enriched gas, which may not be the most economical gas to the public. The importance of the heating value of the gas is now being quite generally recognized, and where new legislation has been adopted recently, and where public-service commissions have considered the question of gas regulation and have gotten to the point of issuing regulations, the heating value standard is being generally adopted, supplemented in some cases by a moderate candle-power standard, the latter with a view to affording the necessary protection to those who still use the open-flame burner.

In view of the growing importance of the question of heating values of gases from the manufacturing, the legislative, the inspecting, and the economic sides, the Bureau of Standards, of the Department of Commerce, started several years ago an exhaustive investigation of the instruments widely used in this country and abroad to measure the heating values of gases, with a view to determining the sources of error to which the instruments are liable, the important precautions to be observed in their use, and the accuracy attainable with them.

This investigation has now been completed, and the results will be published in a forthcoming technologic paper, reprints of which may be obtained by those interested in the subject by addressing a written request to that Bureau. It is expected that the paper will come from the press about June 1.

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Discussion

Casing-Head Gasoline

The Editor:

Sir—I was much interested in the article on page 304 of the April issue of *Western Engineering* on 'Casing Head Gasoline,' and in this connection the following may be of interest to your readers:

In Ure's 'Dictionary of Arts, Manufactures and Mines,' edited by Robert Hunt, published by Longmans, Green & Co., London, and bearing the date of 1879 on the title page and 1878 at the end of the preface, in Vol. IV, on page 569, under the general heading of 'Mineral Oils Industry,' after speaking of the American petroleums, the recent improvements in the Scotch shale oil industry are taken up and then the following appears:

"Gasoline is now obtained from the gas which used to flare up from the educt pipe of the bench of crude oil retorts. Mr. J. Coleman has extracted one gallon of this light liquid, hitherto associated only with petroleum refining, from 1000 cu. ft. of the gas; what gas remained over had heating power, but no luminosity. When the gas was pressed with 10 atmospheres, or 150 lb. to the sq. in., a liquid of 700 sp. gr. was obtained. But if besides this pressure a cold of zero, 32°F., was applied to the gas, a volatile liquid of 0.65 sp. gr. ran out of the educt pipe. An apparatus now successfully extracts gasoline at the Bathgate Works of Young's Company. It has been arranged in cognizance of the fact that gas, when allowed to expand, produces cold, especially if when in the act of expanding it performs such work as driving a piston. The following, in Mr. Coleman's words, are the details involved in the working of the machine:

" '1. The pumping of the gas by steam power into a system of tubes capable of being externally cooled, and from which condensed liquids may be drawn off by ball-cocks.

" '2. Employing the compressed gas (after being deprived of its liquid) for working a second engine, coupled with, and parallel to the first, thus recovering a portion of the force originally employed in compression.

" '3. Employing the expanded gas, after having had its temperature reduced in the act of doing the work of pumping, as the agent for supplying the necessary cold for cooling a portion of the condenser to 18°C., which is about zero Fahrenheit.' "

The above is a true copy and contains the errors which appear in the original, namely, 700 for the sp. gr. of the first liquid obtained by compression when apparently 0.700 was intended, and near the end it says the temperature was 18°C. when it should read −18°C. in order to equal about zero Fahrenheit.

This book has been in my possession since about 1890, and hence to my knowledge the description is older than those quoted from Heinzerling's patent. The Scotch shale oil industry is older than the petroleum industry, many of the shale-oil processes have been utilized in the refining of petroleum, and this part of the process would probably have been used also if the gasoline had been worth saving. As it is, the old process has been forgotten and is being reinvented to supply the demand for gasoline.

E. B. Durham.

Berkeley, California, April 14.

The Antelope Valley Siphon

The Editor:

Sir—I read your statement in the April number of *Western Engineering* on the mishap to the Antelope siphon of the Los Angeles aqueduct with some degree of curiosity as to whether it was an editorial or a contributed article. In any event, it certainly magnifies enormously a minor mishap. There are many single streets in the city of Los Angeles on which the damage resulting from the storm of February 18, 19, and 20 was greater than the combined injuries to the whole length of the aqueduct; *i.e.*, 233 miles.

The statement that the rainfall was light in the vicinity is rather a strange perversion of truth. The average seasonal rainfall there is much less than 10 in., while up to and including the rain of February 18, 19, and 20—that is, in the interval from August 1, 1913, to and including February 20—the seasonal rainfall has amounted to 34.25 inches as shown by the Collins gauge situated at a point a few miles from the Antelope siphon.

It would be curious to know where the

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air valves suggested in your article might be placed on this siphon to either avert or modify the damage, especially in view of the fact that the structure is 'U' shaped without any reverse grades and is wholly open to the atmosphere at both ends.

The pipe, as expected by competent engineers who saw it or heard of it, rounded out perfectly and is now in commission performing its usual function.

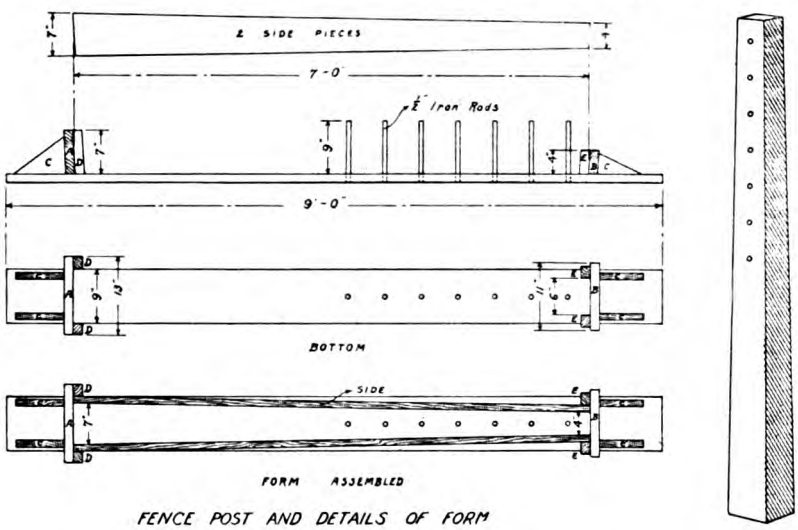
WM. MULHOLLAND.

Los Angeles, California, April 11.

Hints on Practice

Concrete Fence Posts*

There is probably no other article made of cement that is more practical and will pay for itself sooner than fence posts. They are easily and cheaply made, never need replacing on account of rot, are everlasting, requiring no painting, and will not burn. Post moulds are recommended if there is a great deal of this work to be done and can be bought from a number of manufacturers; but for small jobs home-made moulds will answer all requirements. These moulds should be, for ordinary posts, 7 in. square at the bottom and 4 in. at the top, and have a length of 7 ft. The sketch shows one way of making such moulds. On a smooth plank 9 ft. long and 9 or 10 in. wide nail two end-pieces, A and B, each 1 ft. from the end of the plank. Slope these from each other slightly and brace with triangular pieces, C, C. On A nail two vertical 1 by 2-in. pieces, D, D, so that they will be 9 in. apart, and similarly on B nail two pieces, E, E, 6 in. apart. By placing one of each of the side-pieces, which should be made of 1 or ⅞ in. surfaced lumber against the strips D and E, a mould is formed that will give the shape of the post above described. Concrete posts should be reinforced, for which twisted or barbed fence wire is to be recommended. These wires should be 6 ft. 6 in. long, and put in place as the mould is being filled, one being situated in each of the four corners 1 in. from the faces of the mould. Holes should also be provided in the posts for fastening the fence wire, the number and location of the holes depending on the fence being used, and this having been decided on, drill ½-in. holes in the bottom board the proper distance from the top, and before filling in the concrete place ½-in. iron rods, 9 in. long, vertically and well greased in these holes. These rods should be removed before the cement sets hard, or from six to eight hours after moulding. Concrete for posts should be made of 1 part cement, 2½ parts of sand, and 5 parts of rock or gravel that will pass a ¾-in. screen. In filling, follow the same instructions as given for



FENCE POST AND DETAILS OF FORM

*Published through the courtesy of the Pacific Portland Cement Co., San Francisco.

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hitching posts, but it will not be necessary to let these fence posts remain in the moulds as long. This fence post mould is made to be used over and over, and after 24 hours the post should be hard enough to remove the form from it. To do this, place a 1 by 12-in. plank 9 ft. long, called a pallet, on top of the mould and post, and by pressing this plank and the bottom board together turn the mould over. The bottom of the mould can now be carefully lifted off and the sides removed. The post, however, should not be handled until it is at least seven or eight days old, and during this time should be kept wet and protected from the sun. The mould, however, can be immediately cleaned after being taken from the post, and put together again to make another post.

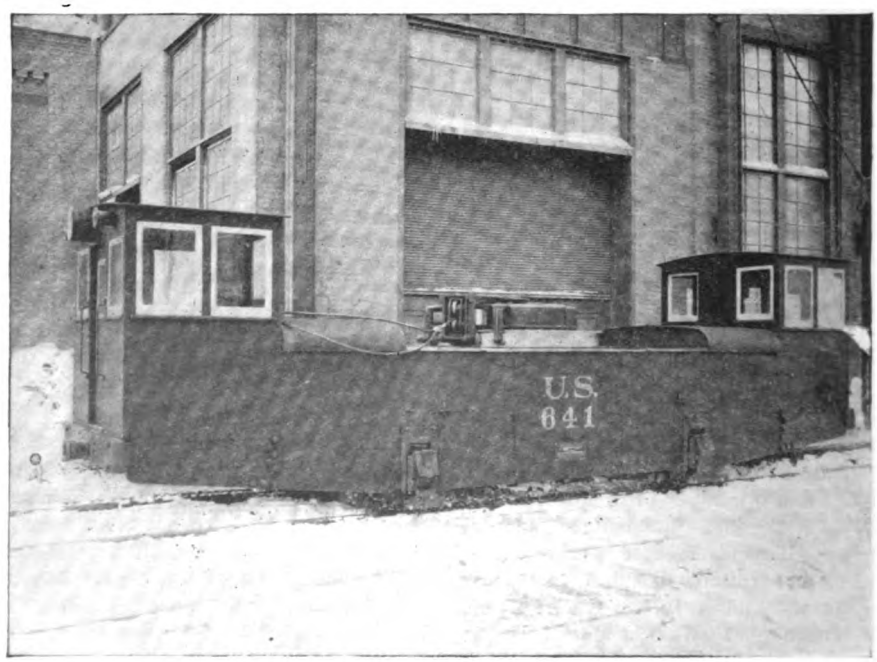
Industrial Progress

Electric Towing Locomotives for Panama Canal Locks

The first lot of electric towing locomotives for hauling vessels through the locks of the Panama canal is now being received at the Isthmus. In all, forty of these 'electric mules' are being built by the General Electric Co. for this purpose. The machines weigh 82,500 lb.; measure 32 ft. 2½ in. long by 8 ft. wide, by 9 ft. 3 in. the greatest height over the cabs; have an available tractive effort as high as 47,500 lb., and a windlass rope pull of 25,000 lb., and four of them, two on each side, will ordinarily propel steamships through the locks. Sometimes six engines will be needed to handle extra large vessels; in every case, two astern, acting as a brake on the ship's movements, will give direction to her course. No vessel will be allowed to enter the locks and go through on her own power.

The locomotive is built up of cast steel side and end frames, cross-ties and bedplates. It is mounted on two axles with wheels in accordance with M.O.B. standards. The entire frame is supported from journal boxes of the regular railway type by means of coiled springs. The sides and top of the body are enclosed by sheet iron covers which fit in place and are very easily removable. At each end are enclosed cabs so that the locomotive may be operated from either end.

The locomotive is propelled by means of a rack rail while towing and while going



ELECTRIC TOWING LOCOMOTIVE FOR PANAMA CANAL LOCKS.

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up or down the steep grades from one level to another at a speed of 2 miles per hour. While running idle or on return tracks, the speed is changed to 5 miles per hour and the machine is propelled by the regular traction method, the rack pinion being entirely released. This change is effected by manually operated clutches in the gear mechanism in connection with a lever in each cab similar to a steam locomotive.

The locomotive is driven by two 75-hp. totally enclosed motors of the mill type, one being direct connected through reduction gearing to each axle. Three-phase, 25-cycle, 220-volt current is used and is collected by contact plows. The motor and traction gearing is mounted on a common baseplate, which in turn is mounted on a driving axle and spring suspended to the locomotive frame as in regular railway practice.

In the centre of the locomotive is a vertical windlass with drum, the capacity of which is 800 ft. of 1-in. steel hawser cable. The windlass with its driving motors and gearing is mounted on a solid baseplate and is likewise independent of the movement of the locomotive frame. The cable drum extends above the locomotive cover and has a floating guard placed around it to retain the cable while coiling loose.

The windlass cable is handled by two 20-hp. motors, also totally enclosed and of the mill type. One is geared for a rope speed of 12 ft. per minute at a pull up to 25,000 lb. at 2 ft. radius, and its function is to adjust the position of the ship for anchor or while being towed through the locks. The other motor is geared for a rope speed of 200 ft. per minute at 2 ft. radius, and its duty is to take up slack or pay out cable or wind in any part of the entire length of cable as may be required. The cable drum is driven through a friction device which can be set at any desired value from zero up to the full capacity of the motor.

The traction motors as well as the windlass motors are controlled from either cab. In other words, the control equipment is duplicated. The two traction motors are operated by one master controller and contactors forward and reverse; while the windlass motors are operated by a reversible drum controller, and the clutch on the main vertical shaft by a solenoid. Later we will be able to give a more detailed description of the mechanical and electrical construction and performance of these machines.

A Centrifugal Pumping Unit for 1400-Ft. Head*

The average reader will probably begin this article with a mental rebuke for the typesetter who put one too many zeros in the title; it may be stated further that this 1400-ft. head means a pressure at the pump discharge of 600 lb. per square inch.

This pump has now been in successful operation for nearly a year on the 1400-ft. level of the North Star mine at Grass Valley, California, delivering water from the sump to the surface 1400 ft. above at the rate of 400 gal. per minute. Under two careful tests conducted independently by the manufacturer and by the owner, the pump developed an efficiency of 72%. The advance of the centrifugal pump has in recent years been so rapid that although it is now used for deep mine pumping, elevator service, fire service, boiler feeding, and other high-head, high-duty work, there still exists among the majority the idea that it is essentially a low-head apparatus.

As a matter of fact, better efficiencies may in general be obtained with high heads than with low, due to the fact that certain losses such as energy due to velocity head, entrance and discharge losses, and bearing losses remain largely constant regardless of head and are therefore a larger percentage of the total energy in low-head pumps than in high. Furthermore, the high pumping heads permit of the use of rotative speed apparatus which for either electric motors or steam turbines is the condition for highest efficiency.

This North Star mine unit consists of a ten-stage turbine type Alberger centrifugal pump, direct connected to a 200-hp. 2200-volt G. E. induction motor operating at 1800 r.p.m. To avoid an excessively heavy pump shaft, the pump is divided into two parts, each of five stages, connected with flexible couplings to opposite ends of the motor shaft, the discharge of the first section being connected to the suction of the second section, the entire unit being mounted on a single cast-iron base preventing alignment difficulties.

Proper hydraulic design of the impeller diffusion vanes and other water passages;

*From data furnished by C. F. Braun & Co., San Francisco.

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the use of a suitable quality bronze for water passages to prevent erosion; machine grinding and polishing of water passages to minimize suction losses; the use of close clearance bushing rings to reduce water short-circuit losses; the careful hydraulic balancing to prevent thrust; the careful rotative balancing to prevent vibration; the use of long packing-boxes minimizing wear on shaft; the use of ample sized ring oiling bearings, and the careful attention to mechanical details, are the features which have made this unit a success.

Norfolk & Western Railway to Electrify

The Norfolk & Western railroad, which extends from the tidewater at Norfolk, Virginia, to the coalfields of West Virginia, has contracted with the Westinghouse Electric & Manufacturing Co. to supply all the electrical apparatus required to electrify the Bluefield-Vivian section of its line, some 85 miles in length.

The carrying out of this contract will give form to one of the most important projects of steam railroad electrification yet undertaken. The contract calls for the manufacture and delivery of twenty-six 130-ton electric locomotives of the single-phase two-phase type, together with all required power-house generating machinery and transmission apparatus.

Single-phase alternating current of a frequency of 25 cycles and at 11,000 volts pressure will be supplied to the locomotives through an overhead suspended trolley wire and will be the identical type of the overhead system that has long been successfully used by the New York, New Haven & Hartford railroad on its main line, by the Boston & Maine in the Hoosac tunnel, by the Grand Trunk railway in the Sarnia tunnel, and by the New York, Westchester & Boston railway, and for which installations the Westinghouse Electric & Manufacturing Co. has furnished over 100 locomotives. The Norfolk & Western single-phase two-phase locomotives, besides being very large and of enormous hauling capacity, will embody many unique features and requirements of design which, it is expected, will result in their showing unprecedented flexibility and economy of operation.

The Bluefield-Vivian section serves the celebrated Pocahontas coal region, one of the largest coalfields in the world. The tonnage of coal handled amounts to 65,000 tons per day, necessitating trains weighing as high as 3250 tons. It is to facilitate the handling of this heavy traffic that the electrical operation has been decided upon.

There are a number of grades on this section, the maximum being 2%, and at the present three Mallet locomotives (the most powerful type of steam locomotives built) are required per train. One locomotive is used at the head of the train and two for pushing.

Only two electric locomotives will be required for this service and the present speed will be double. The extent to which this quick train movement will enlarge the capacity of the railroad is quite apparent.

One of the present impediments to rapid operation of this section of the road is the extension of a 3100-ft. tunnel which is difficult to ventilate. This tunnel, under electric operation, will, of course, owing to the absence of smoke and noxious gases, offer no impediment to frequent train movement.

Since the Norfolk & Western locomotives are intended for handling what is known among railway men as 'tonnage trains' they will be built for running speeds of approximately 7, 14, and 26 miles per hour.

The design of the electric equipment will be such that the tonnage can be readily increased in the future as the service demands. Power for the entire electrified section will be generated in a central power-house at Bluefield, West Virginia, with an installed capacity of 27,000 kw. in turbo generators, supplied by the Westinghouse company. The traffic conditions of this section of the road are especially well adapted to electrical operation. It is in reality a separate engine division at present, and can be operated electrically without affecting the cost of engine service on other sections of the line.

Conditions that are conducive to high economy in an electrification like that of the Norfolk & Western are:

1. Traffic requirements such that a minimum electrical equipment will give practically continuous service.
2. Fewer engine crews per train.
3. The speed of operation over the division will be nearly double that possible with present steam equipment.
4. Increased capacity of electrified section.

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5. Electric locomotives are not limited to the short hours of service on account of boiler and fire conditions as in steam locomotives.

6. Watering and coaling delays incident to steam operation will be entirely eliminated.

7. The general reliability of locomotive operation will be considerably improved.

The contract calls for its completion in the summer of 1914.

Engineer's Note Book

Steam Consumption for Non-condensing Engines*

Steam-power engineers have by intuition a fair idea of the steam consumption that may be expected for engines working under normal conditions of steam pressure and exhaust, both when condensing and when non-condensing; but should these conditions depart from normal it is possible that they will make a 'shot' at it—and it is often a very bad 'shot' indeed.

Too often the fact is lost sight of that steam is merely used in the steam engine as a means of conveying heat, and not for virtues of its own. In the steam engine, as in other motive-power engines, heat energy is converted into mechanical energy, and the virtue in the steam depends principally upon the heat which it conveys, or, more particularly, the heat which is available in it for use in the steam engine.

For the purposes of comparison of steam-engine performances it is usual to consider the performance that would be expected of a perfect engine working with the same conditions of steam-inlet pressure and temperature, and of exhaust pressure and temperature, as in the actual engine performance which is to be compared, the steam being utilized in the perfect engine on the Rankine cycle in accordance with the recommendation of the report of the committee on the Thermal Efficiency of Steam Engines (Proc. Inst. C.E., vols. cxxxiv. and cl.). That is to say, the heat available for work in the perfect engine depends upon steam admission at constant temperature up to the point of cut-off, followed by adiabatic expansion right down to the exhaust back pressure, and complete exhaust at constant temperature equal to that back pressure.

The heat theoretically available for useful work in 1 lb. of dry saturated steam under the above conditions is:

$$U = (Ta - Te)\left(1 + \frac{La}{Ta}\right) - Te \text{ hyp. log. } \frac{Ta}{Te}$$

in which

Ta = absolute temperature at steam inlet;

Te = absolute temperature at exhaust outlet;

La = latent heat of 1 lb. steam at temperature Ta.

(Note: Absolute temperature = temp. degrees F. + 461°.)

The heat units per hour equivalent to 1 I.H.P. will be:

$$\frac{33{,}000 \times 60}{J} = 2545.$$

J = Joule's equivalent = 778 ft.-lb.

The steam (S) required in pounds per hour for 1 I.H.P. developed by a perfect engine, multiplied by the heat units available per pound of steam used, equals the heat units per hour equivalent to 1 I.H.P.; or,

$$S \times U = 2545$$

$$S = \frac{2545}{U}$$

As it is somewhat tedious to find the value of U by calculation for certain conditions, although it may be readily ascertained by reference to the temperature-entropy chart, the accompanying diagram has been prepared to avoid the necessity for making such calculations. It should be noticed, however, that the diagram gives the *theoretical* steam consumption for a perfect engine under varying conditions or the values of $\frac{2545}{U}$ as stated above.

The steam engine in practice actually utilizes only a certain proportion of the available heat, depending upon the efficiency of its performance, which, of course, is affected by its proportions and design. The ratio between the heat theoretically required by a perfect engine and the heat actually consumed by an engine under trial is termed its efficiency ratio. The steam, therefore, actually required by a steam engine working under certain specified conditions is:

$$\frac{S}{\text{Efficiency ratio}} =$$

*Abstract from *Mechanical World*.

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actual steam required in pounds per I.H.P.-hour.

The efficiency ratio can be obtained only from comparisons of actual trials which have been carried out, and its value at full load in engines of the best construction working under particularly favorable conditions with superheat, etc., does not exceed 0.8, while under less favorable circumstances the value may be as low as 0.5.

The diagram may be made to serve the purpose of ascertaining quickly the efficiency ratio of an actual trial; the steam consumption is read from the diagram for a perfect engine working under the conditions of inlet and exhaust pressures prevailing at the trial, and this reading is compared with the actual steam consumption results obtained.

$$\frac{S}{\text{Actual steam consumption in pounds per I.H.P.-hour}} = \text{efficiency ratio.}$$

Example: Actual steam consumption = 42 lb. per I.H.P.-hour, inlet pressure = 105 lb. (gauge), exhaust back pressure 20 lb. above atmosphere. Find efficiency ratio.

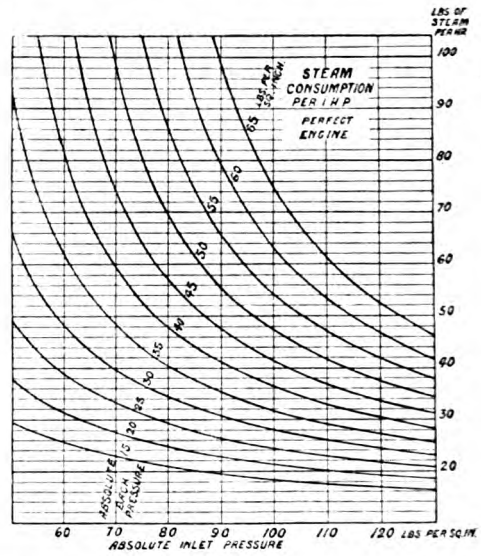
From diagram for 120 lb. absolute inlet pressure and 35 lb. absolute exhaust pressure, S = 27.

$$\text{Efficiency ratio} = \frac{27}{42} = 0.643.$$

As this article has rather in mind engines working under only fairly good conditions with saturated steam and back pressure greater than that of the atmosphere, such as given in the above example, it will not be out of the way to assume for the sake of simplicity that the actual efficiency ratio will lie within the range of the following table:

Add to steam consumption of a perfect engine. Per cent.	Or theoretical consumption to be multiplied by	Efficiency ratio.
40	1.4	0.714
45	1.45	0.689
50	1.5	0.67
55	1.55	0.645
60	1.6	0.625
65	1.65	0.606
70	1.7	0.588
75	1.75	0.571
80	1.8	0.56

If the efficiency ratio is not known, a little judgment, taking into consideration the size of engine and the points which are usually considered as affecting the steam consumption, will enable one to select a fairly suitable value. It appears from records of trials carried out that for any given engine, generally the effect of superheat is to give a high value to the efficiency ratio, whereas working the same engine condensing has the opposite effect. It is not intended by this that a condensing engine has a greater steam consumption than a non-condensing engine, but it does mean that the condensing engine appears to be less capable of utilizing the heat available when that is determined by the Rankine cycle.



Some engines working under the back-pressure conditions already referred to are in use for some manufacturing purposes in which use is made of the exhaust steam for various heating purposes, and, as pointed out before, most steam-power engineers have no notion of the amount of steam that is required for these engines. It would surprise many to learn that with steam at an initial pressure of 100 lb. per sq. in., or 115 lb. absolute, and back pressure of 40 lb. per sq. in., or 55 lb. absolute, the theoretical steam consumption is about 44 lb. per I.H.P.-hour as found from the diagram, and that the actual consumption, if we take as a typical example a consumption equal to 1.6 time or 60% in excess of that for the perfect engine, will be 44 by 1.6 = 70.4 lb. per I.H.P.-hour, the efficiency ratio under such an assumption being 0.625.

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The use of superheated steam has not been considered here, because for engines of the description mentioned above it is but little used, besides which a simple diagram, to cover varying conditions of superheat, is not possible.

Except for such cases where superheat is employed, the diagram is equally useful for steam-turbine work where the exhaust is at a pressure above that of the atmosphere, and especially for reciprocating steam engines working in conjunction with exhaust steam turbines where some back pressure is put on the reciprocating engine.

Book Reviews

GOOD CONCRETE. Riverside Portland Cement Co., Los Angeles.

This work is an interesting and instructive example of the enlightened business methods of today as compared with those in vogue a comparatively few years ago. The remark that has generally been attributed to the late William H. Vanderbilt, namely, "The public be damned," has now changed to 'the public be told.' This book, while frankly what may be classified as a trade publication, is at the same time superior in many respects to the average so-called technical publication dealing with concrete, for the reason that the publishers by putting out a work of this kind accept a responsibility for the data given that does not attach to an author as an individual. The object of the publication is a constructive one, namely, not so much to promote the use of concrete, but of good concrete—and there is a vast difference between the two. Following the table of contents is a brief list of concrete axioms which might well be framed and displayed prominently in the offices of every architect, engineer, and contractor, for if followed we would venture to say that the occasional failure of concrete construction would soon be eliminated. It is by no means infrequent for men who would not under any consideration attempt to design a steel structure of any kind, to undertake without hesitation the design or construction of concrete structures without any previous knowledge or experience. Concrete is a boon to humanity when given a reasonably fair chance to perform its duty according to its unfortunately not always well known and understood physical and chemical characteristics. It is in order to turn the light of knowledge upon this subject that the Riverside Portland Cement Co. has prepared this work for distribution and by so doing has earned a vote of thanks from all who may obtain a copy. The general subject is discussed under the following chapter subdivisions: Portland Cement: Concrete; Proportioning Concrete; The Properties of Concrete; Portland Cement Sidewalks; Portland Cement Curbs and Gutters; Concrete Roads; Specifications for Concrete Roads with Asphalt Oil Wearing Surface; Cement Pipe; Cement Sewer Pipe; Some Suggestions for Care and Return of Empty Sacks.

MANUAL OF HYDRAULIC MINING. By Theo. F. Van Wagenen. D. Van Nostrand Co., New York. P. 117. Index. For sale by the *Mining and Scientific Press*, San Francisco. Price $1.

This is the fourth edition of Mr. Van Wagenen's work, the first having been published in 1897. The original text has been revised and a chapter on dredging has been added. The author's object was to prepare a work that would be practical rather than technical and especially devised for the assistance of the working miner rather than the engineer. The subjects covered are: General Physical Conditions; Methods of Placer Mining and Directions for the Miner; Properties of Water; Construction of Waterways; Fall of Water in Flumes and Ditches; Iron Piping; Nozzles and Discharge; The Sluice; and The Dredge.

THE 'MECHANICAL WORLD' POCKET DIARY AND YEAR BOOK FOR 1914. Published by Emmott & Co. Ltd., Manchester England. P. 330. Index. For sale by the *Mining and Scientific Press*, San Francisco. Price $1.

Since the publication of the issue for last year, the section on steam turbines has been partly rewritten and new data introduced. An extensive section on milling and gear cutting, and another on the milling machine have been added. A table of dimensions of keys based upon British standard proportions is also included, while the table of pipe threads has been rearranged to include both Whitworth and British standard dimensions. There are new tables giving dimensions of hydraulic packing, copper expansion joints, weight of octagonal iron and steel, finished nuts, and set screws.

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Company Reports

The Great Western Power Co. has filed its balance sheet and profit and loss account of 1913 with the Railroad Commission as follows:

ASSETS

Fixed capital	$42,510,266.12
Cash	614,057.34
Accounts receivable	715,776.78
Investments	6,407,312.50
Discount on stocks and bonds	114,774.68
Other assets	1,214,458.20
Deficit	781,547.56
Total	$52,358,193.18

LIABILITIES

Capital stock	$27,500,000.00
Funded debt	22,138,000.00
Accounts payable	455,703.17
Reserved	18,927.76
Other liabilities	1,418,967.98
Surplus	826,594.27
Total	$52,358,193.18

PROFIT AND LOSS

Operating revenue	$1,845,702.58
Operating expenses	534,090.17
Net operating revenue	$1,311,612.41
Non-operating revenue and expenses, net	258,956.06
Total	$1,570,568.47
Less taxes, interest, etc.	1,304,209.02
Total	$266,359.45
Balance December 31, 1912	543,930.21
Total	$810,289.66
Additions	32,085.26
Total	$842,374.92
Other deductions	15,780.65
Balance	$826,594.27

An application has been filed with the California Railroad Commission by the *Modoc County Irrigation Co.* for authority to mortgage its property in a sum not to exceed $750,000 and to issue bonds for the purpose of constructing its irrigation system at Cowhead lake, in the northern part of Modoc county. The Company expects to place 150,000 acres of arable land under its ditch system.

The Happy Valley Land & Water Co. has applied for authority to issue 1000 shares of its capital stock to be sold at par value of $10 per share. Funds to be derived from the sale of the stock will be supplied to liquidating indebtedness and to the construction of a dam to impound water in Happy valley, Shasta county.

An application has been filed by the *Fresno Interurban Railway Co.* asking authority to issue 600 shares of capital stock to be sold at $80 per share and $120,000 in first mortgage 10-year 6% bonds. The railway company is to apply the funds raised by the disposal of stock and bonds to securing its right of way and to the construction of a railroad between Fresno and Clovis.

The application of the *Sawtelle Water Co.*, operating at Sawtelle, in Los Angeles county, to issue $25,000 in 5% 30-year bonds, has been denied. The Company has been granted authority to issue notes in the sum of $10,500 for additions and betterments in the territory near Sawtelle.

The Sacramento Valley Electric Railroad Co. has filed an application with the Railroad Commission asking for an order authorizing the execution of a promissory note in the sum of $16,856.70 to the Oakland, Antioch & Eastern Railroad Co., with the privilege of pledging certain promissory notes as collateral security. The note is to be used in the purchase of steel rails and track equipment necessary for construction work to build the Sacramento Valley Electric Railroad Co.'s line from the town of Dixon, Solano county, to the Oakland, Antioch & Eastern railway.

The Southern California Edison Co., which furnishes light and power to seven counties in the southern part of the State, including Los Angeles, has been heard by the Railroad Commission on its application to sell 30,000 shares of its common capital stock at a par value of $100. The Company has asked permission to sell on contracts to underwriters for a price sufficient to net 82½% of the par value of the stock before June 30, 1915. The Company purposes to expend the proceeds of the sale for extensions and additions, and to reimburse the Company for money expended from the treasury from income not secured.

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Engineering News

Petroleum

Oil dividends in March were as follows:

Standard	$1,025,000
Amalgamated	62,500
American Petroleum	54,362
Caribou	16,140
West Coast	15,000
Western Union	10,000
Section Twenty-five	10,000
Mount Diablo	7,000
Mascot	3,125
Rice Ranch	3,000
Total	$1,206,127

Summary of development and production for all California fields for March, according to the Standard Oil *Bulletin*, is as follows:

Field.	New rigs	Wells: Drilling	Wells: Completed during month	Wells: Abandoned during month	Wells: Producing	Production per day
Kern River	3	7	3	..	1382	19,715
McKittrick	..	3	..	2	266	10,740
Midway and Sunset	30	88	16	..	1262	141,978
Lost Hills and Belridge	7	14	2	1	194	13,444
Coalinga	1	25	4	..	844	43,678
Lompoc and Santa Maria	..	11	..	..	222	12,025
Ventura County and Newhall	6	26	3	..	403	2,846
Los Angeles and Salt Lake	1	6	..	6	682	7,124
Whittier-Fullerton	17	74	5	..	517	34,815
Summerland	..	..	..	..	122	152
Watsonville	..	..	..	..	5	75
Total	65	254	33	9	5899	286,591

Total crude oil stocks, March 31, 1914, 49,847,770 barrels.
Total shipments from fields, March 1914, 8,833,769 barrels.

Irrigation and Water Supply

Taft, Cal.—The Western Water Co. has increased its facilities by installing a 260-hp. Fairbanks-Morse gas-engine and an Aldrich quintuplex pump with a capacity of 725 gal. per minute.

San Rafael, Cal.—A bond election is to be held for the purpose of voting $3,000,000 for the construction of a water-supply system in southern Marin county.

Vallejo, Cal.—Bonds for waterfront improvements in the amount of $42,000 have been sold to the Vallejo Commercial Bank.

Sacramento, Cal.—Plans are under way for the rehabilitation of the irrigation system supplying Orangeville, Fair Oaks, and surrounding districts. The North Fork Ditch Co. will foreclose a mortgage on the California Corporation. Alden Anderson, of the Capitol National Bank, is interested. ——Reclamation District No. 1600, known as the Mull-Merkeley district, about 20 miles north of Sacramento, is preparing to do $280,000 worth of new work this year.—— It is stated that the Sutter Basin company, controlled by W. E. Gerber, of Sacramento, and J. Ogden Armour, of Chicago, have decided to plow their entire holdings consisting of 66,000 acres. It is stated that reclamation work will be completed by June 1915. Colonization will then be undertaken. ——It is stated that the state of California and the federal government will each contribute $2500 for cost of preliminary survey of the Pit River project in Shasta county. W. A. Beard, secretary of the Sacramento Valley Development Association, is interested.

Fair Oaks, Cal.—A movement is under way

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for the formation of an irrigation district under the Wright act, to take over the ditch and distributing system of the North Fork Ditch Co. O. L. Linn is promoting the project.

Woodland, Cal.—A project is under way for the organization of a reclamation and drainage district between the northern boundary of District No. 108 and the mouth of Cache creek. P. A. Haviland, of Haviland, Dozier & Tibbetts, San Francisco, is interested in the project.——Otis A. Birch and B. F. Conoway of Los Angeles have purchased 13,443 acres of land in the Yolo basin for approximately $600,000.

Redding, Cal.—The Anderson Irrigation District has been organized. The officers elected are: President, J. C. Brown, of Cottonwood; secretary, W. C. Barkuloo, of Anderson; treasurer, Bank of Anderson; assessor, S. G. Roycroft, of Anderson; tax collector, H. C. Miller, of Redding; directors, A. W. Smith of Cottonwood, A. J. Shields of Balls Ferry, W. C. Barkuloo of Anderson, H. W. Knapp of Anderson, and McCoy Fitzgerald of Clear Creek. H. H. Henderson is engineer for the company.——A preliminary report has been made by Duryea, Haehl & Gilman, consulting engineers of San Francisco, on the Shasta County Development & Promotion Association's Pit River irrigation project.

Anderson, Cal.—One hundred and sixty land-owners have signed a petition asking the supervisors to create the Anderson irrigation district. It is proposed to divert water from Turtle bay and convey it by canals and ditches as far as Cottonwood.

Montagu, Cal.—A contract has been awarded to C. D. Vincent, of Oakland, for the installment of a municipal water system, excepting the pumping plant, at a cost of $20,700.

Salt Lake City, Utah.—Water-main extensions have been authorized at a cost of $12,575.——A new irrigation district is in process of formation near Mantua, in Boxelder county, for the irrigation of 10,000 acres of land. Arthur K. Chatfield, of this city, is engineer, and P. J. Peterson, of Mantua, is interested. The approximate total cost is said to be nearly $1,000,000.

Lehigh, Utah.—The Utah Lake Irrigation Co. has installed two new pumps with a capacity of 24 sec-ft. each against a head of 100 feet.

Klamath Falls, Ore.—Work has commenced on the new ditch for the Yonna Valley project. Dan Jolley, of Canyonville, is contractor. Cost of project will be about $30,000.

Seattle, Wash.—King and Pierce counties have agreed to expend $250,000 per year for a period of six years on a flood-control project which will embrace construction of a diversion dam on White river to divert the waters down the Puyallup valley to Tacoma. The dam will be made of reinforced concrete with a top width of 4 ft. 6 in. and bottom width of 10 ft. 7 in.; a height of 14 ft. and a length of 1620 ft. There will be 18,100 cu. yd. of excavation, 5840 yd. of concrete, and 26,000 lin. ft. of piling. W. J. Roberts is chief engineer for the Intercounty River Improvements at Tacoma, Washington.

Zillah, Wash.—The Yakima county commissioners have adopted plans and specifications for a drainage district to benefit 200 acres above the Sunnyside canal and 500 acres below the canal. The Government will pay $12,000 of the cost of construction.

Wilbur, Wash.—The City Council has advertised for bids for a triplex pump with a capacity of 200 gal. per minute, driven by a 15-hp. electric motor.

Wenatchee, Wash.—An expenditure of $150,000 will have to be made for betterments on the Wenatchee Canal property. A movement is under foot to transfer the canal to water users. W. T. Clark is interested.

Spokane, Wash.—It is expected that full reports on the Palouse irrigation project will be forthcoming by August 1.

North Yakima, Wash.—An ordinance creating the Capitol Hill irrigation district has been passed by the City Council. A pipeline is to be built.

Streets and Roads

Sacramento, Cal.—The State Highway Commission has called for bids on the following sections of the state highway: Siskiyou county, from Hornbrook to Oregon line, 8 miles of grading. Shasta county, from Lamoine to Hazelton, 9.9 miles of grading. Tehama county, from southern boundary to Corning, 8.8 miles of oiled concrete. Butte county, from Lindo channel to northern county boundary, 11.2 miles of oiled concrete. Glenn county, Grapit to northern county boundary, 7 miles of oiled concrete.

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Glenn county, Grapit to northern county boundary, 4.5 miles of oiled concrete.

The following bids have been received for sections of the state highway: Tuolumne county, from the westerly boundary to Keystone, 10.8 miles, to be graded; estimate, $46,684.30; materials furnished by state, $2019.26: Cyrus and William Moreing, of Stockton, $71,963; Richard Rothwell, Los Angeles, $95,354; Booker & Newell, Jamestown, $55,739.20. Mendocino county, from Forsythe creek to Ridgewood, 6.5 miles, to be graded; estimate, $59,223.85; materials furnished by state, $4967.70: J. D. Niman & Sons, of Turlock, $59,283.50; H. L. Petersen, San Francisco, $65,896.50; Ashby & Moncure, Ripon, $51,793.75; Berry-Mackie & Co., San Francisco, $51,656.90; Shattuck-Edinger Co., San Francisco, $77,678.75; Hard Brothers, Sacramento, $51,381.70. San Diego county, from Las Flores to westerly boundary, 11.5 miles, to be constructed of portland cement concrete; estimate, $74,852.35; materials furnished by state, $24,354.30: W. A. Perry, Los Angeles, $69,935.83; Lynn S. Atkinson, Los Angeles, $92,361; John D. Marsh, Los Angeles, $84,569.45; Rogers Brothers, Los Angeles, $108,054.95; H. E. Cox, Pasadena, $98,085.95; Ernest S. Shields, San Diego, $79,873.90; C. L. Hyde Construction Co., San Diego, $84,584; Richard Rothwell, Los Angeles, $101,483.50; Leigh Garnsay, Los Angeles, $100,043.85. San Diego county, from East San Diego to La Mesa, 2 miles, to be constructed of portland cement concrete; estimate, $12,620.96; materials furnished by state, $6779.68: Holland Construction Co., San Diego, $12,461.50; C. L. Hyde Construction Co., San Diego, $11,741.90.

The following contracts have been let for sections of the state highway: John W. McDonald, of San Jose, for laying an asphalt surface on the state highway between San Jose and Mulia, $15,869. Berry, Mackie & Co., of San Francisco, 4.5 miles of cement concrete highway, Humboldt county, $45,097. Twelve and four-tenths miles of cement concrete work from Dearborn to the north county boundary line of Kern county was awarded to Lynn S. Atkinson, of Los Angeles, for $48,110. In Alameda county, Tieslau Brothers of San Francisco were awarded the contract for building the highway from Hayward to Villa Vista schoolhouse for $19,538. A second Alameda county contract calling for 5.1 miles of asphalt concrete work from Oakland to Hayward went to the Ransome-Crummey Co. of Oakland with a bid of $53,263. Hard Brothers, of Sacramento, were awarded a contract at $51,381 to grade 6.5 miles of highway from Forsythe creek to Ridgwood in Mendocino county. Two San Diego county contracts were awarded as follows: Los Flores to westerly county boundary, about 11.5 miles of portland cement concrete, to W. A. Perry, Los Angeles, $69,935; from East San Diego to La Mesa, about two miles of portland cement concrete, C. L. Hyde Construction Co., San Diego, $11,742. The state highway between Eldorado and Placerville, in Eldorado county, will be let by the Highway Commission on the day-labor basis. Only two bids were received for this work and both were excessive. The State Engineer's estimate is $50,894.

Roseville, Cal.—The City Trustees have let a contract to Joseph Lawrence, of Broderick, Cal., for the construction of a concrete base asphalt wearing surface road at a cost of $15,515.90.

Marysville, Cal.—A petition for a new road through Reclamation District No. 10 has been filed with the supervisors.

Pendleton, Ore.—The construction of a hard-surface road from Umatilla to Pendleton is contemplated.

Prosser, Utah.—Bids will be called for the construction of the new Benton city road.

Spokane, Wash.—Contract for the construction of six miles of extension to the Inland Empire highway has been awarded to Mitchell Bros. at a cost of $39,000.

Walla Walla, Wash.—The County Commissioners have decided to macadamize four miles of road south of Waitsburg.

Ephrata, Wash.—The County Commissioners have let a contract for the construction of permanent highway No. 5 to A. F. Zane & Co. of Hanford.

Wenatchee, Wash.—The City Council has passed an ordinance providing for the improvement of Roosevelt avenue at a cost of $1500.

Waterville, Wash.—Contract has been let for the construction of 3¾ miles of permanent road on the Grant county line to the Moore Construction Co., of Waterville, at a cost of $30,000.

Olympia, Wash.—Contract has been let to H. C. Root & Co., of Spokane, for the construction of 5.7 miles of state road No. 2 in Stevens county at a cost of $8225.——Contract for the construction of 8 miles of Inland Empire highway from Colfax to Step-

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toe has been awarded to O. F. Leonard, of North Yakima, at a cost of $28,686.10. Bids have been called for a 7-mile section from Rosalia south to Cashop.

Wallace, Idaho.—The Shoshone County Good Roads Association has prepared a program for good road construction to submit to the County Commissioners. The City Council has established paving district No. 2.

Nez Perce, Idaho.—The County Commissioners have placed a contract with Harry Mitchell and B. J. Fike for grading 5 miles of road in the northern part of the county at a cost of $7250.

Pocatello, Idaho.—A bond election held for the purpose of providing $100,000 for street improvements resulted in the measure being defeated.

Lewiston, Idaho.—A special election is to be called to provide $100,000 in bonds for highway improvements.

Orofino, Idaho.—The County Commissioners have awarded a contract to McLean, Lanphier, Jansen & Opliger for the construction of 7200 ft. of wagon-road.

Moscow, Idaho.—An ordinance providing for new city pavements is under consideration by the Council. H. J. Smith is city engineer.

Kellogg, Idaho.—The City Council has decided to pave the business district with portland cement concrete at a cost of $11,842. Sidney Shonts is acting city engineer.

Miscellaneous Engineering Construction

San Francisco, Cal.—Plans and specifications have been approved for pier No. 41. The estimated cost will be $300,000.——The Board of Works has awarded a contract to the Clinton Fireproofing Co. for the construction of a central fire-alarm station at a cost of $36,500.——Contract for constructing sewer in the Junipero Serra boulevard has been let to the State Improvement Co. at a cost of $21,165.——The Santa Fe and Southern Pacific companies have commenced construction of a bascule bridge across Islais creek at a cost of $225,000.

Oakland, Cal.—A special election is to be held May 5 to vote upon a bond issue of $500,000 to provide funds for the completion of the municipal auditorium.

Sacramento, Cal.—The Supervisors have approved the bascule type bridge to be erected over the Sacramento river near Walnut Grove. The cost of construction is estimated at $80,000.——The Board of Supervisors has let a contract to the Ross Construction Co. for a 5-span reinforced-concrete bridge, 640 ft. long, with a roadway 21 ft. wide. The cost will be $83,962.——Plans and specifications for a two-story concrete wharf to be erected for the city have been submitted to the City Commission by A. Givan, city engineer.

Portland, Ore.—Guthrie, McDougall & Co., of Portland, have contracted for the construction of 35 miles of railroad in British Columbia and also for a section of track on the line of the Great Northern from Colmont, B. C., to Otter Summit.

Salt Lake City, Utah.—The City Commissioners have voted in favor of ordering the Oregon Short Line railroad to build a viaduct across its tracks at Third street.

Orofino, Idaho.—The County Commissioners have decided to build a steel bridge across Clear Water river at Greer at a cost of $12,000.

Railways

San Francisco, Cal.—The Railroad Commission has authorized the Northwestern Pacific railroad to issue bonds in the sum of $5,534,000 for betterments and extensions.——The Sacramento Valley Electric railroad has been authorized by the Superior Court to continue its construction work in Solano county southeast of Dixon without respect to injunction proceedings. Melville Dozier, Jr., is general manager.——Bids for the construction of the municipal railway from Van Ness avenue and Market street along Eleventh and Division streets to Potrero avenue will be opened by the Board of Works on May 6.

Richmond, Cal.—The Santa Fe railroad is constructing a shed 300 by 1200 ft. for cars.

Oroville, Cal.—The Southern Pacific Co. has let a contract to the Utah Construction Co. for 50 miles of railroad from Westwood, Lassen county, to Klamath Falls, Oregon.

Reno, Nev.—The Nevada-California-Oregon railroad is contemplating improvements to cost between $50,000 and $100,000.

Spokane, Wash.—Announcement has been made of the completion of financial arrangements permitting starting construction work at once on the Spokane-Wallace Interstate

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railway between Coeur d'Alene and Wallace. F. F. Johnson, of Boise, is president.

Clarkston, Wash.—The citizens of Clarkston and Vineland will construct a street railway, the cost to be provided by assessments on real estate in the community. The estimated cost is $45,000.

Denver, Colo.—The Denver & Rio Grande railroad has ordered the construction of new freight terminals near Salt Lake City at a cost of $100,000.

Helena, Mont.—The Ismay, Ekalaka & Southern Traction Co. has incorporated with an authorized capital stock of $500,000 for the purpose of building a gasoline or electric railroad between Ismay, Custer county, and Ekalaka, Fallon county.

Power, Gas, and Electricity

Los Angeles, Cal.—H. E. Huntington has purchased control of the Ventura County Power Co., at a cost said to be approximately $2,000,000.

Santa Barbara, Cal.—The Midlands Counties Public Service Corporation has been incorporated with an authorized capital stock of $2,000,000, of which amount $1,000,500 has been subscribed by William Kerckhoff, A. C. Balch, Kaspar E. Cohen, A. Haas, A. G. Wishon, and A. E. Wishon. The Company has acquired the power-plants at Santa Maria, San Luis Obispo, Lompoc, and other points, and plans for extensions are being made. The new Company is a subsidiary of the San Joaquin Light & Power Co. The principal place of business is Los Angeles.

San Francisco.—The Pacific Gas & Electric Co. has placed an order with the Westinghouse Electric & Manufacturing Co. for motor-generator sets aggregating 6000 kw., to be installed for the operation of the municipal street railway extensions now under construction.——The Mt. Whitney Power & Electric Co. of Visalia has asked permission of the Railroad Commission to issue additional bonds in the sum of $500,000 for betterments.——The application of the Imperial Water Co. to appropriate water for power purposes on Carriso creek in San Diego county, with permission to spend two years in excavation work, has been denied. ——E. A. Wiltsee has applied for permission to appropriate water on Coffee creek, in Trinity county, for a gold-dredging project.

Salt Lake City, Utah.—A mortgage has been filed by the Utah Power & Light Co. to secure a loan of $100,000,000.——The town of Green River, Wyoming, is contemplating the construction of an electric municipal power plant. W. D. Beers, state engineer of Utah, is reporting on the project.

Oroville, Cal.—The Big Meadows dam of the Great Western Power Co. has been completed. The water storage at present covers about 50,000 acre-feet.

Spokane, Wash.—The valuation of the plant of the Washington Water Power Co. is to be undertaken by the State Public Service Commission in order to determine the reasonableness of rates.——C. M. Fassett, county commissioner, gives the following comparative statement of cost of 35 kw-hr. of electric current used as domestic lighting in various cities based upon a 9-room house with 40 to 50-watt, 20-cp. Gem lamps and about 1700 sq. ft. of floor space:

City and ownership.	Cost per month.
Winnipeg, municipal	$1.04
Columbus, municipal	1.05
Cleveland, municipal	1.05
Toronto, Can., munic. distribution	1.63
Niagara Falls, private company	1.93
San Francisco, private company	2.10
Los Angeles, private company	2.10
Tacoma, municipal	2.10
Kansas City, municipal	2.10
Seattle, municipal	2.10
Buffalo, private company	2.30
Oakland, private company	2.45
Montreal, private company	2.65
Spokane, private company	3.35

The power in the above-named cities is generated by water, save in Columbus, Cleveland, and Kansas City, Kansas, where steam is used——The Washington Water Power Co. has purchased from the Lewiston & Clarkston Improvement Co. the transmission lines from Leon station, Nez Perce county, Idaho, to Moscow, Pullman, Uniontown, Genessee, and Colton.

Lewiston, Idaho.—F. W. Emery, A. M. Roberts, W. A. Morey, and L. A. Porter have been appointed as a committee to procure a suitable site on the Clear Water river for a municipal power-plant.

Boise, Idaho.—The Idaho-Oregon Light & Power Co. has commenced work on the completion of the Oxbow power-plant, on the Snake river, at a cost of $220,000.

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Personal

ELLIOTT H. WHITLOCK, consulting engineer, has opened offices at 1506 West 112th street, Cleveland, Ohio.

WILLIAM KEARNEY, state engineer for Nevada, has returned from the National Irrigation Congress at Denver.

ELWOOD MEAD, irrigation engineer, recently delivered an address before the Commercial Club of Salt Lake City.

ARTHUR HOOKER, of Seattle, secretary for the National Irrigation Congress, was a recent visitor in Salt Lake City.

GEORGE W. BOSCHKE has resigned his position as chief engineer for the Oregon-Washington Railroad & Navigation Company.

B. K. STROUD, petroleum engineer of San Francisco, has returned from a trip through the Lost Hills district on professional business.

A. HEIM, geologist of Switzerland, has taken charge of the operations of the Eureka syndicate in the Tapo oil district of California.

ARTHUR L. COLLINS, of San Francisco, has joined the engineering staff of Sanderson & Porter with headquarters in the Nevada Bank building.

E. V. BENJAMIN has resigned his position as manager for the Kern River Oilfields of California, Ltd., and has departed for his home in England.

B. H. BURRELL, engineer for the U. S. Department of Roads, has reported favorably on the proposed Trinity River road in Trinity county, California.

DAVID WARD KING, inventor of the 'split-log' road drag, is making a lecture tour of Western cities for the purpose of discussing the good roads movement.

H. E. WATERBURY, of Pasadena Park, Washington, has gone to Grandview to conduct irrigation experiments in behalf of the U. S. Department of Agriculture.

D. M. BUCK, chief chemist for the American Sheet & Tin Plate Co., delivered an address on the alloy of copper and iron before the Engineers' Club of Seattle.

ANDREW WEIR and R. TILDEN SMITH, of the Western Ocean Syndicate, have been in Los Angeles carrying on negotiations for the purchase of the Union Oil Company.

A. B. WEST, vice-president, and E. B. CRIDDLE, general agent, for the Nevada-California Power Co., have recently made an inspection tour of the Company's transmission lines.

E. MCCULLOH and FRED BONESTEDT, engineers for the U. S. Reclamation Service, have been engaged on the survey of the Palouse project in the vicinity of Pasco, Washington.

A. B. PAULSON, erecting engineer for the C. & G. Cooper Co., Mount Vernon, Ohio, has completed the erection of the natural-gas compressor plant for the Southern California Gas Co. at Taft, Cal., and has returned to Mount Vernon.

CHARLES H. LEE, consulting civil and hydraulic engineer of Los Angeles, has been retained by the U. S. Treasury Department as consulting engineer to advise with the U. S. Public Health Service regarding water-supply at the tubercular sanitorium maintained by the United States Government at Fort Stanton, New Mexico.

Commercial Paragraphs

The WESTERN REINFORCED CONCRETE PIPE Co., a new corporation but with the same stockholders and officials, has taken over the business of the Reinforced Concrete Pipe Co. of Los Angeles, with offices at 525 Central building, Los Angeles.

The MARTIN CEMENT GUN Co. filed articles of incorporation with the Secretary of State on April 17. This Company has been formed for the purpose of controlling and operating all cement-guns used on the Pacific Coast. John S. Martin is president of the new Company, with offices in the Merchants National Bank building, San Francisco.

JAMES C. H. FERGUSON, for the past thirteen years Pacific Coast sales agent of the Midvale Steel Co., of Philadelphia, has severed his connection with that Company and is now the Pacific Coast representative of the William Cramp & Sons Ship & Engine Building Co. of Philadelphia, with his office in the Monadnock building, San Francisco.

W. S. HEGER has recently been appointed by the Busch-Sulzer Bros. Diesel Engine Co. manager of the Pacific Coast sales division, with offices in the Rialto building San Francisco, Cal., from which an aggressive Diesel-engine sales policy will be pursued. He has the assistance of Hugh S. Jones and his son, W. S. Heger, Jr., as sales representatives.

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